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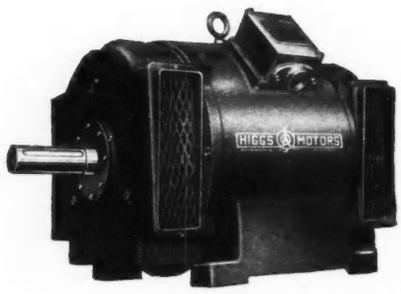

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THE STORY OF ATOMIC ENERGY.

IV.—X-RAYS, RADIOACTIVITY, AND THE ELECTRON.

By Dr. Frederick Soddy, F.R.S.*

In one sense, the story of atomic energy, if it ever began at all, is older than the hills, just as the hills are more ancient than man. For on present-day views—arising entirely out of its story being here told—no other source of energy is known adequate to keep the sun and stars shining even for the tiny fraction of cosmological time during which the hills, and probably also living things in some form, have existed. In much the same sense men, of necessity, have always been familiar enough with energy, though it is a bare century since it was recognised as such; that is, as a single entity or existence behind all its chameleonic manifestations. So far as the general nature of the effects the release of atomic energy may be expected to bring about, our times bear the same relation to the future as the days prior to steam bear to ours, though no one as yet can even imagine the scale of the changes ahead or put a limit on what may now become physically possible.

It has always seemed curious to the writer how little appreciated, in comparison, for example, with the doctrine of evolution, has been the social significance of this sublime conception of energy, which embraces every form of liveliness in contrast to total and unchanging death. It arose directly out of the experiments of Count Rumford, already referred to, on the boiling of water during the boring of cannon by horses, so extending to literal horse-power what savages by unaided man-power had employed to kindle fire. With truly Newtonian sweep, it puts into its proper relationship with the external universe, not only labour but life.

The intellectual and learned world has still to assimilate the change from animal labour to fuel-fed prime-movers. If it be true, as reported, that in anticipation of the coming social millenium, priorities were granted for electric cookers, radiators and the like, but refused for generating stations and plant, it would appear that the ascending sap of the civilisation men so suddenly inherited as a windfall from the work of such men as Count Rumford, has still some way to rise before it gets to the top. In this situation one may be pardoned for not being enthusiastic as to the sort of hands into which has fallen this gift of science to men, multiplying their physical powers a million-fold, or at all comfortable that on some crazy pretext or other they will not deem it imperative to blow up the world with it; but for good or evil the die has been cast.

In the ordinary sense, even the existence, let alone the magnitude, of atomic energy was neither recognised nor suspected till the opening years of the present century. Rather it might as reasonably have been inferred that things so unchanging and unchangeable as atoms, though lively enough externally, internally were totally dead. But the first clear terrestrial manifestation of atomic energy, as distinct from any recognition of it as such, belongs to last century. In three successive years, 1895, '96 and '97, three separate discoveries were made in what at first appeared the same field. The first was Conrad Röntgen's discovery of X-rays; the second, Henri Becquerel's discovery of radio-activity; and the third Sir J. J. Thomson's identification of the cathode ray with the free negative electron.

X-Rays and the Electron.

The first introduced to science a type of radiation utterly indifferent to optical distinctions between opacity and transparency. This, indeed, had been foreshadowed earlier by Lenard's discovery that the cathode-rays of the vacuum tube can pass through thin gold-leaf, and even be studied outside the tube, if a window sufficiently thin be made in it. Though only very feebly penetrating, they are, like the X-rays, absorbed by matter indiscriminately in proportion, roughly, to its density without reference to its transparency. The more spectacular X-rays are generated inside the vacuum tube by these cathode-rays—most abundantly, when they impinge on a dense metal target, called the anti-cathode, put in their path. Fig. 17 shows the form of Sir Herbert Jackson's X-ray tube which had a concave cathode to focus the cathode rays on to an anti-cathode of dense metal and so define the origin of the X-rays. Their amazing powers of penetrating opaque and transparent materials alike, revealing what is inside them by their differences of density, is to-day too familiar to need any description.

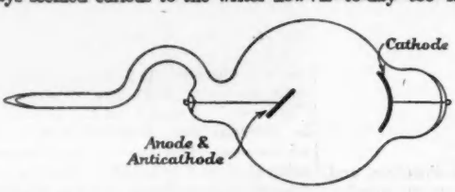

Fig. 17. Sir Herbert Jackson's X-Ray Tube.

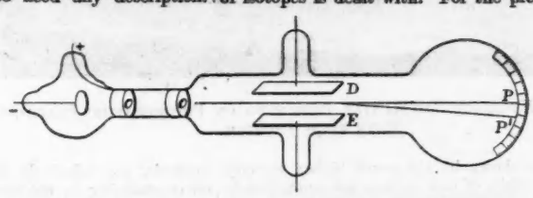

Fig. 18. J. J. Thomson's Cathode-Ray Tube for Measuring $\frac{e}{m}$ for Electrons.

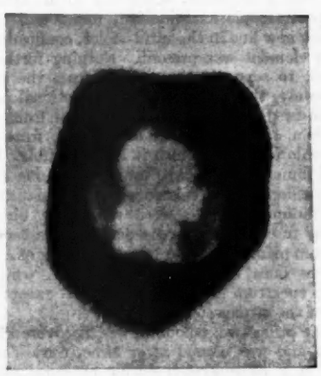

Fig. 19. Becquerel's Original Uranium Radiograph.

They are now known to be a form of light radiation but of wavelength only about one-thousandth of that of visible light. The cathode rays that generate them were shown by the 1897 discovery to be radiant "atoms" of negative electricity, called negative electrons, travelling at speed (in the then state of the art) up to one-tenth that of light.

The atomic character of electricity no less than of matter, as already stated, is the natural way of explaining Faraday's simple laws of electrolysis. For Faraday's "ions" all carry either the same, or simple integral multiples of the same charge, either positive or negative. The method Thomson used to identify the free electron involved the simultaneous deviation of the trajectory of the cathode-ray by magnetic and by electric fields in such a way that the two effects cancelled. This gave the velocity of the electron directly, and also the ratio $\frac{e}{m}$ of the charge to the mass, which was found to be 1,845 times that for the monovalent hydrogen ion in electrolysis. His apparatus is illustrated diagramatically in Fig. 18. The plate D, being charged positively relatively to the plate E, repelled the cathode-ray stream and caused the spot of fluorescent light on the end of the tube to shift from P to P'. A magnet was then brought up to bring back the spot to its original undeflected position. The velocity was then the ratio of the strengths of the electric and magnetic fields, all expressed in C.G.S. units. This known, the ratio $\frac{e}{m}$ of the mass to the charge could then be found from the two separate deflections. Many other experiments, notably those of Sir John Townsend later referred to, went to show that the charge on the electron is the same as that of the monovalent ion, and hence that the mass of the electron is only $\frac{1}{1845}$th of that of the hydrogen atom, or 9×10^{-28} gramme, the lightest particle known to science. The charge on the electron is negative and the accepted value for it is $4{\cdot}8 \times 10^{-10}$ in absolute electrostatic units. For this quantity, whether of positive or negative electricity, the term "atomic charge" is now often used.

The same method, originally in the able hands of Sir J. J. Thomson and his assistant, F. W. Aston, has been vastly extended and now forms by far the most accurate method, not only for the determination of the chemists' atomic weights, but for determining the weight of the chemists' atoms, which is not the same thing; as will appear later when the discovery of isotopes is dealt with. For the present it must suffice to explain that the word "isotope" meaning "the same place" was coined in 1913 by the writer for elements identical in chemical properties, the atoms of which are quite different.

Radioactivity.

Though chemistry is not exactly "a French science founded by Lavoisier" as one of the latter's compatriots claimed in the opening words of his history of that subject, certainly radioactivity is a French science discovered by Henri Becquerel; it was the 1896 discovery, in between those of the X-ray and the electron, that alone opened the door to the new world. At first it seemed, and in any less advanced scientific age would certainly long have remained, little more than a curiosity. Becquerel, looking for X-rays in phosphorescence and fluorescence, a subject in which his father and grandfather had specialised, had the good fortune to use some of their fluorescent salts of the element uranium, and found them capable, like the X-rays, of darkening the photographic plate through thin metal sheets. Moreover, he and other physicists by 1899 had established the identity of these Becquerel rays with the cathode-rays of Crookes and Lenard, which Thomson had just shown to be radiant electrons, the only difference being that some of them were travelling at much higher speeds, at first, up to one-third that of light. Now some of them are known to travel at speeds hardly less than that of light.

But Becquerel almost at once found that they were not due to fluorescence at all, as the action went on in the dark just as well as in sunlight. This is what makes it rank as the greatest discovery of all time. Fig. 19 is a reproduction of M. Becquerel's original uranium radiograph. To obtain it, a photographic plate in a light-tight envelope was exposed for some days to the rays from a patch of uranium oxide covered with an aluminium medallion. The thinner parts of the medallion shielded the plate less than the thicker parts, causing the head of the figure to appear in the radiograph. What Crookes, Lenard and Röntgen had made the latest developments of high-tension electricity and high-vacuum technique accomplish, the element uranium was doing of itself, and, moreover, doing it much more

* We have arranged with Dr. Soddy to publish his new book, *The Story of Atomic Energy*, in the form of a series of articles which will appear at fortnightly intervals approximately. Dr. Soddy, however, retains the copyright; therefore no extract may be made from these articles without his permission.—Ed. E.

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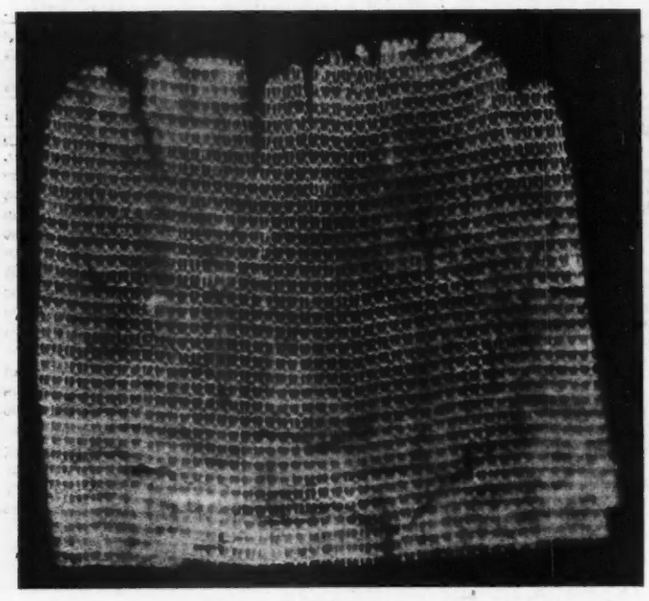

FIG. 20. WELSBACH GAS MANTLE IMPRINTED ON PHOTOGRAPHIC PLATE BY RAYS FROM THORIUM.

FIG. 21. RADIUM WRITING.

powerfully, as shown by the much higher velocity of the rays. This, of course, was not immediately appreciated at its full significance. For one thing, the effects are extremely minute, and long exposure to the photographic film is necessary for it to be detectable at all, though that soon was to change. But well into this century, Lord Kelvin, for example, maintained the alternative view that the radioactive substances might be acting as transformers of some previously unrecognised form of external energy, and not as energy generators. The change of scale came, as is well known, through the work of M. and Mme. Curie, but was started by the latter, before her marriage; she was then Mlle. Marie Sklodowska, a Polish research student in chemistry at the Sorbonne in Paris.

She began the quest by a patient examination of as many as possible of the rest of the elements, some 80 or more, to see if any were, like uranium, radioactive, and found that one was, namely, thorium, to much the same feeble extent as uranium. This important discovery was made simultaneously by a German investigator, G. C. Schmidt. It is significant that the Periodic Table of the chemical elements in order of atomic weight ends with uranium, and that thorium was next to it, with one "place" then vacant between them, so that these two had the heaviest atoms then known. The radioactive properties of thorium are illustrated in Fig. 20, which shows a Welsbach gas mantle imprinted by its own rays. The mantle, after cutting open and pressing flat, was burnt off and laid on the film side of a photographic plate covered with an opaque leaf of aluminium and left in the dark for some weeks. The illustration is a positive of the negative so obtained, and shows how the thoria, of which the mantle is composed, has imprinted its own image by the rays it emits. The starting point of the wonderful series of discoveries to follow, however, was that pitchblende, and all the other natural minerals in which uranium exists, are several times more radioactive than can be accounted for by the uranium in them. From this observation, in due course, came the new intensely radioactive elements, polonium, radium and actinium, discovered by M. and Mme. Curie, the last with A. Debierne.

THE NEW RADIOELEMENTS.

The first announcement of the discovery of radium was made in 1898. The barium, separated from pitchblende by the ordinary processes of chemical analysis, was relatively strongly radioactive, and, on crystallising its chloride from aqueous solution, the activity is concentrated in the crystals, the mother liquor being impoverished. By the end of that year a specimen, submitted to M. Demarçay for spectroscopic examination, was found to give a strong new line in the ultra-violet, confirming that a new element was present. Nothing further was needed, to separate the radium from the barium completely, than the systematic fractional crystallisation of the barium chloride, at first from water, and then, as the quantity diminished, from dilute hydrochloric acid in which it is less soluble. Later, Giesel found it quicker to use the bromide instead of the chloride. In this way minute quantities of pure radium chloride were ultimately obtained. As the fractionation proceeded, a complete new spectrum made its appearance, consisting of a dozen or more lines of important intensity, while the barium spectrum gradually faded out, except for a trace of the strongest barium line.

Of the other two, polonium was discovered before radium and was named after Mme. Curie's native land. It is concentrated during chemical analysis with the bismuth in the mineral. Its radioactivity was later found not to be permanent, but to decay away completely in the course of a few years. Actinium is concentrated with the rare-earths present in the mineral. On present knowledge, its activity would take one or two centuries to decay completely. Both exist in the mineral only in unweighable quantity, and though they may be concentrated indefinitely from the elements accompanying them, they cannot, like radium, be separated as pure elements. The radioactivity of polonium is peculiar in that it comprises only the one very feebly penetrating type of rays, now termed the α-rays, to be discussed later.

Just as the advent of the spectroscope had almost at once resulted in the discovery of several new elements in minute quantities in natural sources, the spectrum being the tag or label enabling the new element to be followed and concentrated during chemical separations, so it was with these new elements. It is important to note that, in using the radioactivity as an identifying label, Mme. Curie had practically completely determined the chemical character of radium and its place in the Periodic System, as a heavier homologue of barium, long before enough had been separated to show even the very characteristic spectrum of radium, let alone to be weighable. The other two have never yet been obtained in quantity sufficient to show even their spectra. Nowadays radioactive forms, or "isotopes," of almost all the known elements can be manufactured artificially, on a like scale of minuteness. This has led to a similar method of using them as "tracer elements"—*i.e.*, to trace the passage of the ordinary elements with which chemically they are identical. It is achieving an enormous vogue in fields far removed from the physical sciences; for example, by biologists in following the passage of substances through the living body.

RADIUM.

When finally isolated in a pure state, the salts of radium proved to be many millions of times more radioactive, weight for weight, than uranium, giving strong fluorescence as well as photographic and ionisation effects. With the pure preparations, the atomic weight of radium was determined and found to be 226. This work, however, required large-scale factory operations handling tons of pitchblende, and these naturally took a considerable time, for there is only one three-millionth as much radium as uranium in the mineral. The energy evolution was not calorimetrically measured till 1903, and it then proved to be over 100 (actually 135, as later found) calories per gram of element every hour. So that in less than two days radium gives out spontaneously, weight for weight, more energy than in the most energetic chemical changes known, such as in combustion and detonation. As we now know, the rate will slowly diminish as the centuries roll by, but even if it maintained its original rate, it would last for 2,300 years. The total output of energy is well over a million times that evolved by the same weight of any combustible or explosive material. Fig. 21 is a reproduction of "radium writing." It is a positive from a negative obtained by writing, as with a pencil, on a photographic plate enclosed in a light-tight envelope, with a tube containing a few milligrams of a radium preparation. The effect is due mainly to the β-rays.

But perhaps the principal contribution of Mme. Curie to the progress of the science was not radium, magnificent and epochal as it was. It was the guiding principle of her researches, at which she arrived early and maintained in the face of all apparent exceptions, that radioactivity was an atomic property. Like the spectrum of an element it is a property of the atom, but radioactivity is a property of the atom only, unaltered by its chemical combinations with other atoms to form molecules, and totally uninfluenced in quantity or quality by any agency then known. The only other such property is the atomic mass. There is, in fact, a certain resemblance between radioactivity and astronomy in that the investigator is, or rather was,

THE STORY OF ATOMIC ENERGY.

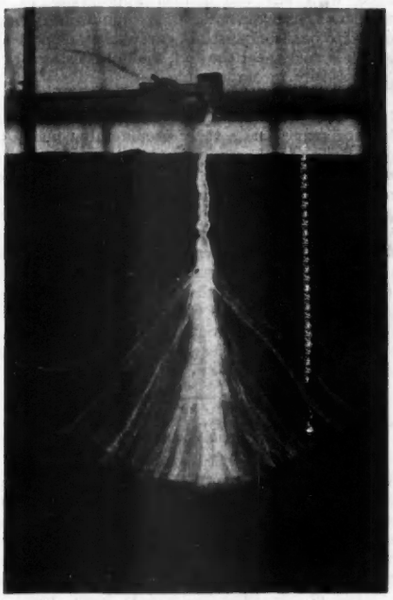

FIG. 22. SILK-TASSEL ELECTROSCOPE CHARGED.

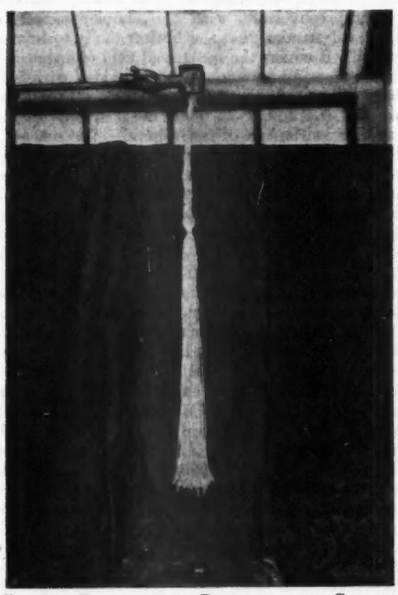

FIG. 23. ELECTROSCOPE DISCHARGED BY CAPSULE OF RADIUM.

a mere onlooker. Not that it looked so at first! For as soon as it began to be intensively studied it appeared fickle as the wind.

THE IONISATION OF GASES.

We must now turn to the early work of Ernest, afterwards Lord, Rutherford, who at the time this story opens, 1895, had recently graduated from Canterbury College, Christchurch, N.Z., and was working as a research student with Sir J. J. Thomson at Cambridge. One of the investigations had to do with an electrical effect produced by X-rays and also the rays of radioactive substances, namely, their power to "ionise" gases. This is illustrated in Figs. 22 and 23, of which the former shows Sir James Mackenzie Davidson's silk-tassel electroscope, which has been charged by stroking the floss-silk tassel with a warm dry tobacco pouch. It is instantly discharged, as shown in Fig. 23, by the ionisation of the air caused by X-rays or radium in the neighbourhood. The rapid progress soon to be made was due largely to their theory of the process, worked out 1897-99, which enabled it to be applied to the precise measurement of the intensity of the rays and, therefore, of radioactivity; but the fact of the "ionisation" itself had been discovered by Becquerel almost as soon as the photographic action of the rays, and had been the subject of numerous investigations by him for two years before the theory was understood.

Normally, air, for example, is a complete insulator, but becomes temporarily a conductor of electricity, though only to a limited extent, when irradiated by these new rays. They showed that the effect was much as in liquid electrolysis, due to what Faraday had named ions, which are positively- and negatively-charged molecules, the difference being that these ions are produced by the rays in gases, whereas in liquids that conduct the electric current they exist ready-made. In gaseous ionisation the ions are only generated by the absorption of energy provided by the radiations, and when left to themselves the ions at once recombine and disappear. Owing to this, Ohm's Law, which applies to metallic conduction and, in modified form, to the electrolysis of liquids, is not obeyed. The current at first increases as the voltage is increased, much as for Ohm's Law, but then more slowly and soon reaches a maximum value called the "saturation current," and no longer increases with the voltage. This happens because the number of ions is limited and, for the saturation current, the voltage is sufficient to drive them to the electrodes so quickly that the loss on the way through recombination is negligible.

ALPHA, BETA AND GAMMA RAYS.

This theory of the process was itself a great physical advance, but, more important in this connection, invaluable in practice, in that it became possible to supplement the photographic method with excessively delicate electric methods of detecting and measuring these new rays. The first result of the electric method of detection and measurement, though anything but immediately arresting, was in due course to prove much the greatest. Rutherford showed that uranium is giving, in addition to the penetrating rays that pass through thin metal sheet, a relatively non-penetrating radiation that produces by far the greater part of the ionisation. These rays he named α-rays, to distinguish them from what he termed the β-rays, which are, as already stated, radiant electrons, like the cathode-rays, and later were shown to be responsible for practically all the photographic effect of uranium. In his hands, the α-rays were to prove the master key by which the energy of the atom was first unlocked, withal, until long after his death, only on the single-atom scale. It is safe to say no other had the experimental genius which that required.

But first, to complete the tally of radiations, the third type, the γ-rays, must be mentioned. These are feeble and were discovered in 1900 by Villard when active radium preparations became available, though then found to exist also in the rays of uranium and thorium and of most of the newer radio-elements. They are distinguished by a penetrating power then truly astonishing, but are not deflected by the magnetic field. The γ-rays of radium require $\frac{1}{2}$-in. thickness of lead to reduce their intensity to one-half, and can easily be detected after passing through over a foot. In this peculiarity, however, they have now been eclipsed by the excessively feeble cosmic rays which reach the earth from outer space, some of which behave as though hundreds of times more penetrating than the γ-rays of radium. The γ-rays, like the X-rays, are a form of light radiation, but of excessively short wavelength, and they stand to the β-rays much in the same relation as X-rays to cathode-rays. Though practically of very great interest owing

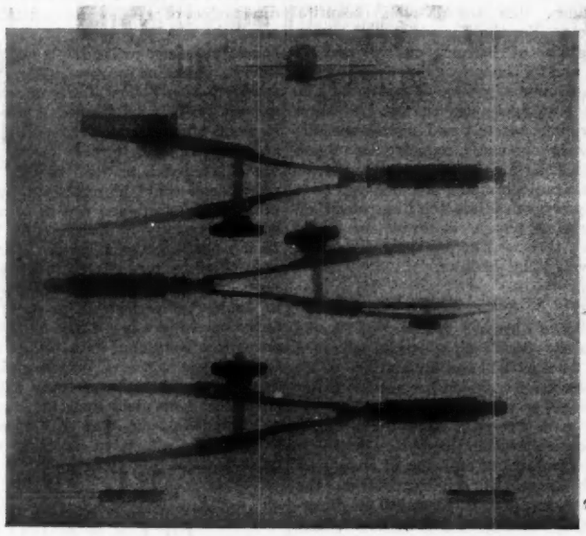

FIG. 24. RADIOGRAPH OF BOX OF SPRING BOWS, TAKEN WITH GAMMA RAYS OF RADIUM.

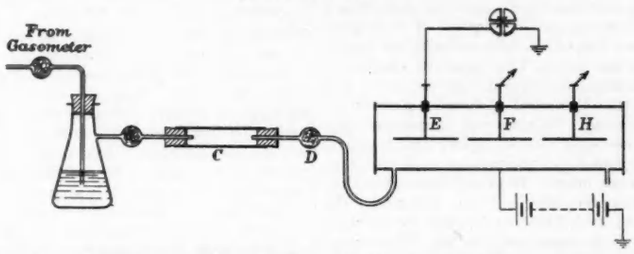

FIG. 25. RUTHERFORD'S APPARATUS FOR MEASURING THE THORIUM EMANATION.

to their penetrating power, they were not, at least at first, of such theoretical importance as the other two types. All three types, when sufficiently powerful, produce, like the X-rays, beautiful fluorescent effects. For the X-rays, β- and γ-rays, the platino-cyanide of barium, or willemite, a sillicate of zinc, and for the α-rays, Sidot's hexagonal blende, a form of zinc sulphide, or powdered diamond, are the best fluorescers to use. All three effects, photographic, electric and fluorescent, are now ascribed to the one cause, namely, the process of ionisation described for the second. Fig. 24, on page 507, shows a radiogram of a box of spring bows taken with the γ-rays of radium and illustrates their extreme penetrating power, as even the metal adjusting screws, traversed across their diameters, cast only relatively light shadows.

The Emanations and Active Deposits.

In 1898, Rutherford became Professor of Physics in McGill University, Montreal, where he remained until 1907, and here he laid the foundations of his life-work on radioactivity, which became his major preoccupation, right up to his death in 1937. Early in 1900 he had made known a discovery destined, as it proved, to clear up within three years the whole mystery of the spontaneous emission of energy by radioactive substances. It originated from the observation of the Professor of Electrical Engineering, R. B. Owens, working with Rutherford, that the radioactivity of thorium is very sensitive to draughts! This, the latter showed, was due to the thorium compounds, unlike those of uranium, giving off, in addition to straight-line radiation, a radioactive "emanation" or vapour. It is stopped by the thinnest film of air-tight material but readily permeates porous septa, like paper or cardboard. Hence no chemical separation, but merely a puff of air, is all that is needed to remove it from the thorium compound. So removed, its radioactivity, which comprises only α-rays, rapidly and regularly decays in a geometrical progression with the time, to one-half in one minute, from any time of starting, becoming inappreciable in ten minutes. The apparatus used by Rutherford in these experiments is illustrated diagrammatically in Fig. 25, on page 507. The thorium compound is enclosed in the tube C, through which a stream of dried air is passed from a gasometer into the testing cylinder on the right, a plug of glass wool being placed in a bulb D in the connecting tube to remove any ions originally present in the air. The three electrodes E F H in the testing cylinder are usually connected together and to one pair of quadrants of an electrometer, the other pair of quadrants being connected to earth. The outside of the cylinder is connected to one pole of a high-tension battery, the other pole of which is earthed. By these means the ionisation in the cylinder due to the thorium emanation is measured, and by measuring the separate ionisation currents to the three electrodes the rate of decay of the emanation can be determined. Another property is that all surfaces in contact with the emanation develop, in the course of time, what Rutherford first termed "excited activity," but is now called the "active deposit." This activity comprises all three types of rays.

The surface "excited" behaved as if covered with an invisible film of strongly radioactive material, which can be rubbed off by sand-papering, and dissolved off by acids, some being more effective than others, and recovered unchanged by evaporating the acid. Its radioactivity also is only temporary, but lasts much longer than that of the emanation, taking two days, after removal from the latter, to disappear completely. The active deposit, when surfaces positively and negatively charged are offered to the emanation, is concentrated almost wholly on the latter, so that, if this is, for example, a needle point, very concentrated sources are easily prepared.

Contemporaneously, M. and Mme. Curie had found that radium compounds have a similar property of causing what the French investigators termed "induced radioactivity" in substances in the neighbourhood. The corresponding radium emanation, now called radon, not then having been discovered, the Continental scientists naturally thought their "induced activity" an effect of the rays of radium, somewhat like phosphorescence. But Rutherford knew his "excited activity" was an effect of the thorium emanation, and not a direct effect of the thorium radiation. These names recall the crucial question at that time, though of course not then realised. Were these phenomena due to induction or production, to excitation or transmutation? For if the emanation and active deposit are being continuously produced out of the element thorium, this, since radioactivity is an atomic property, implies a transmutation. On the other hand, as first thought in France, the phenomena could be explained by supposing that radioactive substances can in some unknown way cause temporary radioactivity in the materials in their neighbourhood. It was later found that not only thorium, but also radium and actinium, give both emanations and active deposits, all different in their "half-periods," or time taken for the radiation to decay to one-half, that of radium emanation being four days, and of actinium emanation a few seconds. For the active deposits, the decay is more complex, but the half-period for that of thorium is normally some 11 hours, that of radium about half-an-hour, and that of actinium a little longer. The effects in all three cases were thus quite parallel.

LITERATURE.

Practical Aircraft Hydraulics. By S. G. Bloxham. Sir Isaac Pitman and Sons, Limited, Parker-street, London, W.C.2. [Price 18s. net.]

According to the author's preface, the accent in the title of this book should be on the word "practical"; he presupposes in the reader a knowledge of aircraft, but not of hydraulics. This assumption involves propounding the theory of hydraulics in a form which, however brief, should be concise and accurate; but in fact the theoretical preamble is hardly to be described as concise and occasionally it is not entirely accurate. Comparisons are sometimes repeated unnecessarily; the phrasing in places is liable to puzzle the beginner; and the examples given for changing the directions of motion of a jack by mechanism are, in practice, particularly difficult to accomplish satisfactorily. These criticisms, it should be stated, originate from Chapter I; thereafter the text improves considerably, though somewhat marred by the intrusion of the first person. Many chapters contain a considerable amount of most useful information, but the recurrence, at varying intervals, of loose wording or poor syntax spoils what is evidently the product of much labour. Mainly, the text is compiled from the inspector's point of view, but advice to users, designers and manufacturers is often mixed together. The illustrations are good and clear, a point which deserves to be emphasised in these days of paper restrictions, which are frequently a responsible cause of poor diagrams and half-tone reproductions.

The text deals almost exclusively with the products and methods of one company, a feature which might have been permissible if the fact had been specifically stated; but it is not, and features peculiar to the one company have been described as if they were general throughout the industry. Sometimes this is immaterial, but in many places it is not so. To illustrate the above comments, the following cases may be cited. The only type of hydraulic fluid mentioned appears to be castor base; the these fluids are now used on a comparatively small proportion of aircraft, the greater proportion using petroleum-base fluids. Viscosity is not, as it is stated, a relative degree of stability, and the Ford cup is not a standard instrument for measuring viscosity. To assert that "when fluid is passing round a circuit, it is in a state of turbulence" is misleading; the flow may be laminar. In normal circumstances, waves and impulses are not used for transmitting power in aircraft hydraulic systems. Pure rubber is never used as a gland material, even with castor-base fluids; the material should be compounded natural rubber. It is difficult to appreciate the derogatory reference to synthetic rubber, which is essential for mineral-base oils. The "length" of a jack is not generally known as its "stroke." The advice to fill the reservoir to the neck of the filler may be correct in certain instances, but would be positively dangerous in others; the method of filling should be in accordance with the instructions appropriate to the system. Throughout the book, liquids are wrongly stated to be incompressible, except that, on page 115, which is fairly near the end, the fluid is stated to be "practically incompressible."

A shock absorber which took one minute to recover (page 130) would be quite unsuitable on an aircraft landing gear; and a taper needle only controls the orifice size. It has no effect on the volume of oil displaced. Finally, the propeller in Fig. 72, is not mounted on the engine shaft, as indicated, but on the propeller shaft, which is geared down from the crankshaft. Without this independent geared-down shaft, a hydraulically-operated variable-pitch propeller becomes exceedingly difficult to arrange. The above is not an exhaustive list, but perhaps it is sufficient to indicate the need for some revision, if a second edition is required; given that revision, the book should be very helpful to those who are studying hydraulics for aircraft.

Applied Thermodynamics. By Dr. A. C. Walshaw. Blackie and Son, Limited, 66, Chandos-place, London, W.C.2. [Price 30s. net.]

Whatever other shortages engineers may have to suffer, it seems unlikely that they will ever have cause to complain of a dearth of new text-books on thermodynamics. The present treatise has been written for the benefit of "engineering students preparing for present-day examinations in the higher reaches of the subject," and is based upon the author's notes for lectures to candidates for engineering diplomas and degrees. It is to such students, already conversant with the simpler aspects of thermodynamics, that the book is likely to be most useful; it covers the recognised field of engineering thermodynamics, and is amply provided with fully-worked examples as well as more than 200 questions of the A.M.I.Mech.E. and B.Sc. standard, with answers at the end of the volume. The scheme of the book is systematic, and the manner of presentation concise. The latter virtue has not been attained, however, without a sacrifice of some of the lucidity of the best of the older text-books, particularly where algebraical reasoning is concerned; neither is such reasoning made easier to follow by the lavish use of symbols affected with one or more subscripts, which may demand frequent reference to some diagram or other to verify their meaning. The extent to which brevity is sometimes carried is shown by the reference to the Willans Line, which is confined to four sentences with no illustration. It is surely rather hard to expect a student, with no more information than this, to give an intelligent answer to one of the questions which requires him to discuss the Willans Law and the deductions that can be drawn from it in the case of a particular engine. However, since the book is not intended for beginners, these matters may not be considered of the first importance.

The first part of the volume, about a quarter of the whole, deals with general principles and calculations common to all branches of the subject. The remainder is divided into three sections, relating more particularly to "Steam Plant," "Internal Combustion Engines," and "Compressors and Refrigerators," respectively. The units employed are those most familiar to practical engineers, namely, feet, pounds, B.Th.U., etc. The convenience of the mol, or pound-molecule, as a unit in simplifying and shortening calculations concerning combustion, flue gases, partial pressures, etc., is rightly insisted on, as every student should be familiar with it. The practical aspects of engineering receive scanty consideration, and might have been omitted altogether without much loss. Moreover, the reader would do well to verify some of the statements before accepting them. He will find, for example, mention of "stokers burning up to half a million pounds of coal per hour." A stoker capable of doing this would need a grate area of something like a quarter of an acre. The explanation given of the observed rise in flue-gas temperature, when an undue amount of excess air is admitted to the furnace, also is not likely to be accepted by power-station engineers. The author accounts for

it on the theory that the excess air causes the production of soot, with the consequent fouling of the boiler heating surfaces. Apart from the fact that excess air is most unlikely to produce soot, the generally accepted and more reasonable explanation of the rise in temperature is that the cooling of the furnace by an abnormal amount of air lessens the amount of heat absorbed by radiation, and thus leaves more to be carried away by the gases. Again, in the chapter on steam engine plant, the only illustration, apart from diagrams, is of a triple-expansion marine engine, with an exhaust turbine "revolving at about 200 r.p.m.," connected to the propeller shaft by reduction gearing and a long chain drive. Even if the speed of the turbine can be laid at the door of the printers, the type of the plant seems hardly representative of marine practice.

Sub-Station Practice. By T. H. CARR, M.I.C.E., M.I.Mech.E., M.I.E.E. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 32*s.* net.]

THE three main items making up an electricity-supply system are the power stations, the transmission and distribution lines, and the substations. All of these have received extensive treatment in technical literature, but most of the books and institution papers dealing with them are concerned with one or more particular aspects of their subjects. In his well-known and valuable two-volume work entitled *Electric Power Stations* (the second editions of which were reviewed on page 427, vol. 157 (1944), and page 102, vol. 159 (1945), respectively). Mr. Carr covered the whole field of power-station design, from the civil-engineering work to the electrical protective equipment, treating also of organisational methods and station costs. In this new volume he deals with substations on the same broad, but inclusive lines. Many papers concerned with switchgear, transformers and converting plant have been read before technical institutions, but the average engineer cannot be expected to have studied more than a very small part of them. These three types of plant, however, constitute the main machinery equipment of substations and a treatment of them on general lines is likely to be widely useful.

The book has no case to make, and in dealing, for instance, with converting plant, no attempt is made to favour mercury-arc rectifiers at the expense of rotary or motor converters, although in this case present-day general practice has come down very definitely on the side of the mercury rectifier. There are, however, large numbers of substations with rotary-converters still in operation, and it is proper that machines of this type should receive the attention which Mr. Carr gives to them. The question of switchgear equipment is in a more fluid state, and although the air-blast circuit breaker is establishing a firm position for itself, it has not yet demonstrated that it will ultimately eliminate the oil breaker. The impartial information given in this book on this and cognate matters is likely to be of value to many who have to decide on the equipment of a substation. In the case of large supply authorities, the results obtained with previous installations will usually be available, but works engineers may be called upon to decide on the equipment of a works substation. For these, the information given in this book will furnish useful guidance.

This matter of the relative qualifications of different types of equipment is by no means the only subject covered by this volume. It deals with the general considerations determining the capacity of substations and the factors which may influence the choice of sites. The various types are then described, a useful table giving costs of characteristic examples. This matter may well be influenced by the situation of the station in reference to surrounding property and the difficult questions which may arise when electrical considerations dictate that a substation shall be located in a built-up area are dealt with in an interesting and informative way. A section of the chapter dealing with general considerations summarises the various statutory requirements which the substation designer has to keep in mind. The final chapter concerns organisation and control, and covers operation regulations, plant commissioning, inspection and maintenance.

MOVING LOADS ON CONTINUOUS BEAMS.

By J. J O'DONOVAN, B.Sc.(Eng.), A.M.I.C.E.I.

(*Concluded from page* 486.)

CASE II.—*Continuous Beam of Two Equal Spans, with Both Ends Fixed, and Value of E I Constant.*—Here again the values of K are equal. Starting with a load on A B, we get

$$M_A = +\frac{x(l-x)(4l-3x)}{4l^2};\quad M_B = \pm\frac{x^2(l-x)}{2l^2};$$

$$M_C = +\frac{x^2(l-x)}{4l^2},\ i.e.,\ M_C = -\tfrac{1}{2}M_B$$

$$R_A = \frac{l-x}{l} + \frac{M_A - M_B}{l} = \frac{4l^3 - 9lx^2 + 5x^3}{4l^3}$$

$$R_B = \frac{x^2(3l-2x)}{l^3};\quad R_C = -\frac{3x^2(l-x)}{4l^3}.$$

The maximum B.M. at A = 0·1685*l*, occurring when the load is at 0·3772*l* from A. It is evident that the maximum value of the B.M. at C will also be 0·1685*l*, occurring when the load is at 0·3772*l* from C.

For the minimum value, consider the equation for the B.M. at C. As pointed out before, the plus sign indicates a tendency to cause convexity downwards, that is, the bending moment is really negative, as at D in Fig. 1, page 484, *ante*. By differentiating, we get minimum B.M. at C = −0·0370*l*, occurring when the load is on the span A B, at 0·6667*l* from A. The minimum value of the B.M. at A will have the same value, occurring when the load is on the span B C at 0·6667*l* from C.

The maximum value of the B.M. at B will be 0·0741*l*, occurring when the load is on A B at 0·6667*l* from A, or on B C at 0·6667*l* from C. When the load is at X on A B at *x* from A, $M_X = M_A - R_A x$, and is negative. The maximum value is −0·1450*l*, occurring when the load is at 0·5683*l* from A or C.

It will be seen that the greatest value of the bending moment is 0·1685*l* and occurs at the fixed ends A or C.

Values of the bending moments at A, B, C and X are given in Table III, and plotted in Fig. 9, page 510. Here again M_X is always negative, but, for convenience, is plotted above the base line. It will be noted that, whereas the B.M. at B is always positive, those at A and C change sign, being positive when the load is on the adjacent span, and negative when it is on the farther span. Influence lines for bending moment or shear force at a point can be obtained as was done for the case of the beam with pinned ends.

CASE III.—*Continuous Beam of Two Equal Spans, A B and B C, with End A Fixed and End C Pinned. E I is Constant.*—Here the values of K will be 1·0 for span A B, with end A fixed; and 0·75 for span B C, with end C pinned. We have to consider two cases: (i) the load on the span A B; and (ii) the load on the span B C.

(i) When the load is on the span A B at *x* from A, we get:—

$$M_A = \frac{x(1-x)(7l-5x)}{7l^2};\quad M_B = \frac{3x^2(l-x)}{7l^2};\quad M_C = 0.$$

$$R_A = \frac{(l-x)(7l^2+7lx-8x^2)}{7l^3};\quad R_B = \frac{x^2(18l-11x)}{7l^3};$$

$$R_C = -\frac{3x^2(l-x)}{7l^3}.\qquad M_X = \frac{4x^2(l-x)(3l-2x)}{7l^3}.$$

(ii) When the load is on the span B C at *x* from C:—

$$M_A = -\frac{x(l^2-x^2)}{7l^2};\quad M_B = \frac{2x(l^2-x^2)}{7l^2},\ i.e.,\ M_B = -2M_A.$$

$$R_A = -\frac{3x(l^2-x^2)}{7l^3}\ \text{(downwards)};\quad R_B = \frac{x(12l^2-5x^2)}{7l^3};$$

$$R_C = \frac{(l-x)(7l^2-2lx-2x^2)}{7l^3};$$

$$M_X = \frac{x(l-x)(7l^2-2lx-2x^2)}{7l^3}.$$

When the load is on A B, the maximum value of the B.M. over the central support is 0·0635*l*,

TABLE III.—TWO SPANS: BOTH ENDS FIXED.

Value of *x*.	0·1.	0·2.	0·3.	0·4.	0·5.	0·6.	0·7.	0·8.	0·9.
M_A	0·0832	0·136	0·1627	0·168	0·1562	0·132	0·0997	0·064	0·0292
M_B	0·0045	0·016	0·0315	0·048	0·0625	0·072	0·0735	0·064	0·0405
M_X	0·0146	0·048	0·0866	0·12	0·1406	0·144	0 1286	0·096	0·0506
R_A	0·9787	0·92	0·8312	0·72	0·5937	0·46	0·3262	0·2	0·0887
R_B	0·028	0·104	0·216	0·352	0·5	0·648	0·784	0·896	0·972

Value of *x*.	1·1.	1·2.	1·3.	1·4.	1·5.	1·6.	1·7.	1·8.	1·9.
M_A	−0·0202	−0·032	−0·0367	−0·036	−0·0312	−0·024	−0·0157	−0·008	−0·0022
M_B	0·0405	0·064	0·0735	0·072	0·0625	0·048	0·0315	0·016	0·0045
M_X	0·0506	0·096	0·1286	0·144	0·1406	0·12	0·0862	0·048	0·0146
R_A	−0·0607	−0·096	−0·1102	−0·108	−0·0937	−0·072	−0·0472	−0·024	−0·0067
R_B	0·972	0·896	0·784	0·648	0·5	0·352	0·216	0·104	0·028

NOTE.—Values of M_C, the bending moment at C, can be obtained from those for M_A, the bending moment at A. Thus, when *x* = 0·4, M_A = 0·168, and M_C = −0·024; and when *x* = 1·6, M_A = −0·024, and M_C = 0·168. Also, R_C can be found from $R_A + R_B + R_C = 1·0$.

TABLE IV.—TWO SPANS: END A FIXED AND END C PINNED.

Value of *x*.	0·1.	0·2.	0·3.	0·4.	0·5.	0·6.	0·7.	0·8.	0·9.
M_A	0·0830	0·1371	0·165	0·1714	0·1607	0·1371	0·1050	0·0686	0·0321
M_B	0·0038	0·0137	0·027	0·0414	0·0536	0·0617	0·0630	0·0549	0·0347
M_X	0·0144	0·0475	0·0864	0·1207	0·1429	0·1481	0·1346	0·1024	0·0555
R_A	0·9797	0·9234	0·8380	0·7303	0·6071	0·4754	0·3420	0·2137	0·0974
R_B	0·0241	0·0903	0·1890	0·3109	0·4464	0·5863	0·7210	0·8411	0·9373

Value of *x*.	1·1.	1·2.	1·3.	1·4.	1·5.	1·6.	1·7.	1·8.	1·9.
M_A	−0·0244	−0·0411	−0·0510	−0·0548	−0·0536	−0·0480	−0·0390	−0·0274	−0·0141
M_B	0·0489	0·0823	0·102	0·1097	0·1071	0·096	0·078	0·0548	0·0283
M_X	0·0460	0·0942	0·1386	0·1742	0·1964	0·2016	0·1866	0·1490	0·0672
R_A	−0·0732	−0·1234	−0·1530	−0·1646	−0·1607	−0·1440	−0·1170	−0·0822	−0·0424
R_B	1·0221	1·0057	0·9550	0·8743	0·7679	0·6400	0·4950	0·3371	0·1707

When the load is on B C, the maximum value is 0·11*l*, occurring when the load is at 0·577*l* from C. It will be seen that this value is greater than the maximum value obtained when the load is on A B. When the load is on A B, the maximum value of the B.M. at the fixed end is 0·1716*l*, occurring when the load is at 0·3837*l* from A. When the load is on B C, the greatest value is −0·055*l*, occurring when the load is at 0·577*l* from C.

When the load is on A B, the greatest value of the B.M. under the load is −0·1486*l*, occurring when the load is at 0·5784*l* from A. When the load is on B C, the maximum value is −0·2019*l*, occurring when the load is at 0·4225*l* from C.

The greatest bending moment on the beam occurs under the load when this is on the span B C at 0·4225*l* from C. Its amount is −0·2019*l*.

Values of the bending moments at the fixed

end, A, the centre support, B, and under the load at X are given in Table IV, page 509, and plotted in Fig. 10. Here again, M_x, although negative, is plotted above the base line.

As an example of the practical application, consider the case of a continuous beam A B C of two spans, A B = 30 ft., and B C = 20 ft., with the end A fixed and the end C pinned. The values of I are: A B, 600; B C, 200. E is constant. Here the ratio of the values of K for A B and B C would normally be 2 : 1; but, since the end C is pinned, we reduce the value of K for B C to 0·75. The results of the calculations, worked out as for Case III, are given below :—

Bending Moment over the Central Support, B.—When the unit load is on the span A B, the maximum value is 1·21 tons-ft., occurring when the load is at 20 ft. from the fixed end A. When the load is on the span B C, the maximum value is 2·8 tons-ft., occurring when the load is 11·55 ft. from the pinned end C.

Bending Moment at the Fixed End A.—When the load is on the span A B, the maximum value is 5·37 tons-ft., occurring when the load is at 12 ft. from the fixed end; and when the load is on the span B C, the bending moment is numerically half that over the central support, but negative. The maximum value is −1·4 tons-ft., occurring when the load is at 11·55 ft. from the pinned end C.

Bending Moment under the Load.—When the load is on the span A B the maximum value is −4·71 tons-ft., occurring when the load is at 18 ft. from the fixed end. When the load is on the span B C, the maximum value is −3·82 tons-ft., occurring when the load is at 8 ft. from the pinned end C.

Absolute Maximum Bending Moment.—The greatest bending moment on the beam occurs at the fixed end A, when the load is on the adjacent span A B, at 12 ft. from the fixed end A.

CASE IV.—*Continuous Beam of Three Equal Spans, with Ends Pinned and Value of E I Constant.*—Here two cases have to be considered, namely, a load on outer span A B or C D, and a load on the centre span B C. The values of K will be 0·75 for the outer spans and 1·0 for the centre span.

Unlike the case of the continuous beam of two spans, exact values cannot be obtained for the bending moments at B and C, but only approximate values, as in the case of the continuous beam of three spans worked out in Fig. 1. The work can be carried to any desired degree of approximation, but too great a refinement in this direction is obviously a waste of time, since the British Standard Specification for rolled-steel sections allows a variation of up to 2½ per cent. above or below the nominal weights.

When the load is on the end span A B, $M_B = \frac{4x(l^2 - x^2)}{15 l^2}$ approximately, and the maximum bending moment at B is 0·1026*l*, occurring when the load is at 0·577*l* from the pinned end A. When the load is on the central span B C, $M_B = \frac{x(7l^2 - 12lx + 5x^2)}{15 l^2}$ approximately, and the maximum bending moment at B is 0·0801*l*, occurring when the load is at 0·3837*l* from B. The maximum values for C will obviously be the same as those for B, when the load is in the corresponding position. When the load is on the outer span A B, the bending moment at C is numerically one-fourth of that at B, but negative in sign. The minimum value of the bending moment over the supports is, therefore, −0·0257*l*, occurring at C when the load is on A B at 0·577*l* from A, or at B when the load is on C D at 0·577*l* from D.

When the load is on the outer span A B at x from A, $M_X = \frac{x(15l^3 - 19l^2x + 4x^3)}{15 l^3}$ approximately. The maximum negative value is −0·2049*l*, occurring when the load is at 0·4275*l* from the pinned end A. When the load is on the central span B C, $M_X = \frac{2x(4l^3 + l^2x - 10lx^2 + 5x^3)}{15 l^3}$ approximately. The maximum negative value is −0·175*l*, occurring when the load is at 0·5*l* from B.

The greatest value of the bending moment which can occur on the beam is −0·2049*l*, occurring under the load when the load is on one of the outer spans and at a distance of 0·4275*l* from the nearest pinned end. The greatest positive bending moment is 0·1026*l*, occurring over one of the inner supports, B or C, when the load is on the outer span adjacent to that support and at 0·577*l* from the pinned end.

CASE V.—*Continuous Beam, A B C D E, of Four Equal Spans, with Ends A and E Pinned, and Value of E I Constant.*—The values of K will be 0·75 for the outer spans, A B and D E, and 1·0 for the inner spans B C and C D. When the load is on A B at x from A, $M_B = \frac{4x(l^2 - x^2)}{15 l^2}$ approximately; that is, about the same as for M_B in the case of three equal spans with the load on the outer span. The maximum bending moment will be 0·1026*l*, occurring when the load is at 0·577*l* from the pinned end A. When the load is on one of the inner spans, as B C, at x from B, $M_B = \frac{x(l - x)(4 \cdot 1\, l - 3x)}{8 \cdot 81^2}$ approximately. The maximum value is 0·0792*l*, occurring when the load is at 0·3807*l* from B. This is very nearly the same as for the case of the three-span continuous beam. Assuming that the maximum bending moment under the load will occur when the load is on one of the outer spans, A B, at x from A, practically the same values are obtained as for the case of the beam of three spans, that is, the maximum negative value is −0·2049*l*, occurring when the load is at 0·4275*l* from the pinned end A. The absolute maximum bending moment is −0·2049*l*, occurring under the load when the load is on one of the outer spans and at a distance of 0·4275*l* from the adjacent pinned end.

CASE VI.—*Continuous Beam, A B C D E F, of Five Equal Spans, with Ends A and F Pinned, and Value of E I Constant.*—The maximum value of the bending moment over the support is practically the same as for the two previous cases, namely, 0·1026*l*, occurring when the load is on one of the outer spans, A B or E F, and at a distance of 0·577*l* from the nearest pinned end.

Assuming that the maximum bending moment under the load will occur when the load is on one of the outer spans, as A B, at x from A, here again the maximum negative value will be practically the same as for the two previous cases, namely, −0·2049*l*, occurring when the load is at 0·4275*l* from the pinned end A.

In conclusion, it will be noted that, when there are three or more spans, the values of the greatest positive and negative bending moments remain practically constant. The greatest positive bending moment is about 0·1026*l*, occurring over the second support from the end, as B, when the load is on the adjacent outer span and at a distance of 0·577*l* from the nearest pinned end A. The greatest negative bending moment is about −0·2049*l*, occurring under the load, when this is on one of the outer spans at 0·4275*l* from the nearest pinned end.

The bending moment under the load is always positive; but the bending moment over the intermediate supports is positive for the support nearest to the load, negative for the next support, then positive and negative. This change in the sign of the stress must be taken into account when fixing working stresses.

Fig. 9.

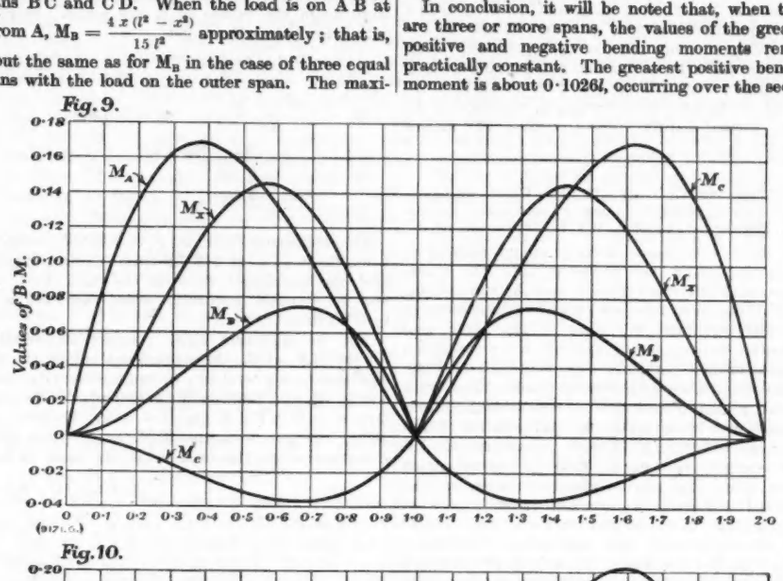

Fig. 10.

DRAGLINE EXCAVATOR FOR IRON ORE.—Messrs. Ransomes and Rapier, Limited, Waterside Works, Ipswich, announce that they have received an order from Messrs. Stewarts and Lloyds, Limited, for a very large walking dragline excavator for the winning of ironstone by opencast methods. The machine will have a weight of 1,500 tons; the capacity of the bucket will be 20 cub. yards, and the length of the boom 282 ft. Power will be supplied by two electric-generator sets, each of 1,500 h.p. The machine will be in continuous operation for 24 hours each day. The digging and walking controls will be handled by one man.

THE EARLY HISTORY OF PATENTS FOR INVENTION.*

By M. Frumkin.

(*Continued from page* 486.)

Venice, which inherited its main industries, and particularly the making of glass and silks, from Byzantium, was the first State in western Europe to issue laws concerning industry. In 1322, a certain *Teuthonicus ingenerius* promised to build some remarkable kind of corn mills, and agreed to submit them to a practical test. A decree was issued, granting up to 80 pounds for that test, which had to be performed by two wise men, Leonardo Aymo and Philippo Bellegno. In 1332, Bartholomeo Verde made a similar offer. Again a practical test was decreed, together with conditional rewards, depending upon the results, which included long-term credits and the gift of a site for the mills. Then, in 1443, a third mill-maker, Antonius Marin, of France, requested not only a free site, but also an exclusive privilege, debarring all others in Venice from making mills not needing waterpower during the term of 20 years. Other patents followed in 1460 and 1472, till, in 1474, the Venetian Senate, by 116 ayes against 10 noes, 3 abstaining, voted the first of all patent laws. The text of that law was published by Professor Mandich, as translated from the original text, written in old Italian. It is as follows:

"MCCCCLXXIIII March XVIIII

There are in this City and its surroundings, attracted by its excellence and greatness, many men of divers origin, having most subtle minds and apt to imagine and discover divers ingenious artifices. And if it were provided that others may not make nor take unto themselves to increase their own honour the works and artifices they may have seen so discovered by such men, such men would use their minds, and would discover and make things which would be of no little utility and advantage to our state.

Therefore.

It is enacted by the authority of the present Council that whoever will make in this City any new and ingenious artifice, not made previously in our state, will be obliged to register it at the office of our proveditors of the Commune, as soon as it will be reduced to perfection ('reducto chel sara a perfection') so that it will be possible to use and apply it. It shall be forbidden to anyone else in any our land and place to make any other artifice to the image and similarity of that one without consent and licence of the author during the term of ten years. And if nevertheless someone did it, the aforesaid author and inventor would be free to cite (him) before every office of this City, and the said who would have imitated would be compelled to pay one hundred ducats, while the artifice would be immediately destroyed. But our Government will be free, at its complete discretion, to take over and use for its needs any of the said artifices and instruments, under the condition, however, that others than the authors may not employ them."

The law of 1474 was not strictly applied: patents were granted in Venice in considerable numbers, but usually not for ten years. In reality the terms were longer, but always divisible by five or ten, a custom which still prevails in most countries but the English-speaking ones. A long list of Venetian patents, over a hundred, is given by Professor Mandich, who stops at the date of 1550; a date at which authors dealing with the patent systems of other countries are quite happy to begin. The outstanding merit of Professor Mandich is not diminished by the fact that a few early patents he mentions had been discovered before.

The next period was a time of decline for Venice. It is true that patents were granted there in the Seventeenth Century, and even in the Eighteenth, till the end of the "oldest state in Europe"; but the last patents were granted not to ingenious men attracted by the splendour of the "*mirabilosissima civitas*," but to sneaking emissaries who tried to find abroad some new methods in order to rejuvenate the decaying industries at home. At the very end of the republic, in 1790, the old glory of the Venetian glass industry had to be revived by a privilege granted for bottle-making in the English manner.

It is possible that at Genoa, also a city renowned for glass and silks, patents were granted in numbers, but the author has not been able to find any material supporting that view. An early patent for gilding earthenware was granted by the Duke of Urbino. Later, the Pope issued a curious patent to a Venetian Jew, Magino Gabrielli, who invented a method to increase the yield of silk. In 1587, Magino received from Sixtus V not an exclusive privilege, but the right to collect in the pontifical State royalties during 60 years from all those who would use his method. The grant is motivated, among other things, by the fact that the applicant stated that he would print his method and publish it during nine consecutive days on public places of the State in order to facilitate the use of his invention by the public. Magino printed, in 1588, a book, now very rare, with engravings, *Dialoghi di M. Magino Gabrielli Hebreo Venetiano sopra l'utili sue inventioni circa la seta.* The author has not been able to ascertain whether that book can be considered as a patent specification, as it seems that no copy of it exists in this country. A year later, Magino received a patent for an oil used for polishing mirrors and cut glass, but it does not seem that there was any print relating to that second grant.

While Venice had attained such a surprising state of development, England was "basking in economic innocence," but this was not to last, as "economic power, long at home in Italy, was leaking through a thousand creeks and inlets into western Europe" and "the forces destined to dominate the future tried their wings." These quotations could not be better applied than to the appearance of the English patent system after 1550. We note two "creeks and inlets" introducing patents to England: the first coming directly from Italy, the second, indirectly, from Antwerp, where Italian glassmakers caused the appearance of a patent system some years before it originated in England. A letter from Sir Antonio Guidotti, one of the numerous Italians then in English service, shows admirably how patents were suggested or almost pressed upon a Government which was still reluctant to introduce such a novelty. That letter, the earliest known English patent application, was dated in Naples, March 20, 1537, and was addressed to Thomas Cromwell. The original is partly burnt, but there is at the British Museum a translation in contemporary English. Guidotti proposed to introduce silk weavers from Italy and made the request that "one only grace I demaunde from your lordeship in this affaire, which is to be intermediator to the kinges Majestie to one privilege for 15 or 20ti yeris no man to may within the realme make or let make any such kind of werke, but under me and my name." And then follows a reference to Antwerp: "The emperors Majestie two yeris passed being here in Napolles dyd gyve grete previleges and gifts unto 2 brethren named Francys and Augustin Cordes, Myllaners (Milanese), for to set up the said craft at Antwarpe."

The application did not aim at an invention patent proper, as no new and specific invention was involved; but such an application prepared the way for real patents, in the same way as, somewhat later, an anonymous book, *A Discourse of the Common Weal of this Realm of England*, which, though printed for the first time in 1581, describes conditions in 1549, when there was still no patent system in England. In that book, one, Dr. Pandotheus says: "In venis as I heard, and in many other places beyonde the sea, they weare rewarded and cherished, everie man that bringes in anie new arte or mistorie whearby the people might be set aworke." This quotation and its context show that there could be no privileges in England for "anie new arte or mistorie," and that the mere idea of such privileges had to be borrowed from Venice.

At that time another English financial agent, Thomas Gresham, began his brilliant career, being appointed to Antwerp at the end of 1551, where he lodged with Jasper Schetz, the principal agent of Emperor Charles V, who granted many patents both in Germany and in Antwerp. Here Gresham had an opportunity to observe a flourishing patent system and report his observations to Cecil. We still do not know whether Gresham mentioned the Antwerp patents in his reports to Cecil, the same Cecil who was to become the soul of the new English patent system. A research in Gresham's manuscripts would perhaps yield illuminating results. Gresham could observe not only a patent system introduced into Antwerp by more or less humble Italian artisans, but also an obnoxious network of big-scale monopolies, of which Gresham's friends, the Augsburg family of Hochstetter, were, together with the Fuggers, those greatest of all merchant princes, the main supporters; so there could be some basis for the assertion that the English monopoly system has been built up mainly by Germans.

The beginning of the English patent system is variously put at 1561 (Hulme) or 1552 (Davies and Gomme). The 1552 patent was granted to one Smyth for glass, just as was the somewhat mysterious privilege given to John Utynam a century before. In this respect, the first English grants confirm what could be called an almost universal rule. The 1561 patent, Hulme's No. 1, was granted to two immigrants for making Castile soap. At that time, Acontio, an Italian, requested a patent in England after the custom of his own country. The importance of that application has been denied for, though published in the State Papers for 1559, the true date of the document might have been 1565, when patents were already implanted in England. Furthermore, Tomazo Chanata, another Italian, also applied for an English patent, prior to Acontio. In 1565 we see another Italian patentee in England, Francis Berty, native of Antwerp. The same Berty appears as early patentee in other countries.

The list compiled by Hulme provides another proof that the English system had been imported from abroad. It is well known that the traditional term for English patents was 14 years (sometimes also 7 or 21), a figure never seen on Continental grants. That term was linked by Sir Edward Coke with another traditional English term of seven years—namely—the duration of apprenticeship. The early patentee was expected to train apprentices, so as to disseminate the knowledge of his art after the expiry of the privilege. In Venice, and many other European States, patents were granted for terms divisible by five or ten. In Hulme's list of the early English patents, the first seven were all granted for ten or 20 years, the subsequent ones being mixed, partly granted for what could be called Venetian terms, and partly for English. At a later period, all patents are granted for terms divisible by seven: the system had been entirely acclimatised in England.

In Scotland, in spite of the then most primitive economic conditions, already in 1565 "Francisco Berty, Floretine" contracted with Mary, Queen of Scots, "anent the making of greit salt within our realm of ane new sort and fassioum." Such was the real identity of "Francis Berty, native of Antwerp," already noticed. Thus started the Scottish patent system, which seems to be very little known. Scottish ideas about patents were certainly very sound, witness the clause inserted in a grant of 1606 for an invention concerning coal mining: the patent was to be valid, provided its subject-matter was "ane work and ingyne nocht knawin in this kingdome at na tyme before." In 1610, there is a patent for glass, followed in 1612 by a privilege "to bring in strangers to make red herrings." The terms of Scottish patents were variable, 19 years being quite usual (the same term as often applies to Scottish farm leases), though in 1611 a 21 years' monopoly was granted for refining silver with quicksilver, water and salt. Among the more curious patented inventions were, in 1694, "ane engine for writing, whereby five copies may be done at the same time," and, in 1699, "wooden kettles and cauldrons which could abide the strongest fire."

Scottish patents were often granted by Parliament, as in the case of Hudson and Partner, who petitioned for their lately invented engine for freeing coal-mines from water, doing more work in an hour than other engines could do in a week, and received a 19 years' privilege in 1693. In Ireland, as in so many other countries, it seems that the first patents were granted for glass, and one Woodhouse was named as a patentee in that art in 1586. Another patent for glass followed in 1602; and in 1634 one Sir Percival Hart was granted a monopoly for "black glass drinking cups and vessels and pots similar made at Murano and commonly called Venice drinking glasses"; the patent was to last 21 years and an annual fee of 50 marks had to be paid for it.

No industry contributed more to the prosperity of Venice than the making of glass, or more exactly, small mirrors and fanciful drinking cups; and it is not surprising to see the many restrictions the Government of the republic decreed in order to prevent an emigration of the masters of that very precious and somewhat mysterious art from the island of Murano, where they were more or less secluded. There were many reasons for leaving Venice, particularly when the old city lost its commercial supremacy to Antwerp after the discovery of America. About 1550, conditions became so bad for the Venetian glassmakers that, for the first time, they were allowed to go abroad. Some others, who had not waited for that permission, were already established in foreign countries. Being the depositories of such precious secrets, they did not want to part with them without a safeguard against possible local competition. Coming from Venice, they were obviously familiar with patents, and asked for patent protection abroad. Soon, patents for "verre à la façon de Venise" were known in all civilised Europe, and that term became a commonplace phrase. It was with the help of these humble artisans that an institution, now so important, was transplanted to all industrial countries with the exception of Germany.

(*To be continued.*)

* Paper presented at a joint meeting of the Chartered Institute of Patent Agents and the Newcomen Society, held in London on November 12, 1947. Abridged.

Institute of British Foundrymen.—A special meeting of the Institute of British Foundrymen, to mark the twenty-first anniversary of the appointment of Mr. T. Makemson, M.B.E., as secretary, will be held at the Waldorf Hotel, Aldwych, London, W.C.2, on January 16, 1948. A buffet luncheon will be given at 1 p.m., after which a presentation will be made to Mr. Makemson by the President, Mr. P. H. Wilson, O.B.E. At 3 p.m., Sir Arthur P. M. Fleming, C.B.E., director of research and education to the Metropolitan-Vickers Electrical Company, will deliver a lecture on "The Inter-Relation of the Engineering and Metallurgical Industries."

HIGH-ALTITUDE TEST CHAMBER FOR AIRCRAFT.

MESSRS. DE HAVILLAND AIRCRAFT COMPANY LIMITED, HATFIELD.

FIG. 1. GENERAL VIEW OF TESTING CHAMBER.

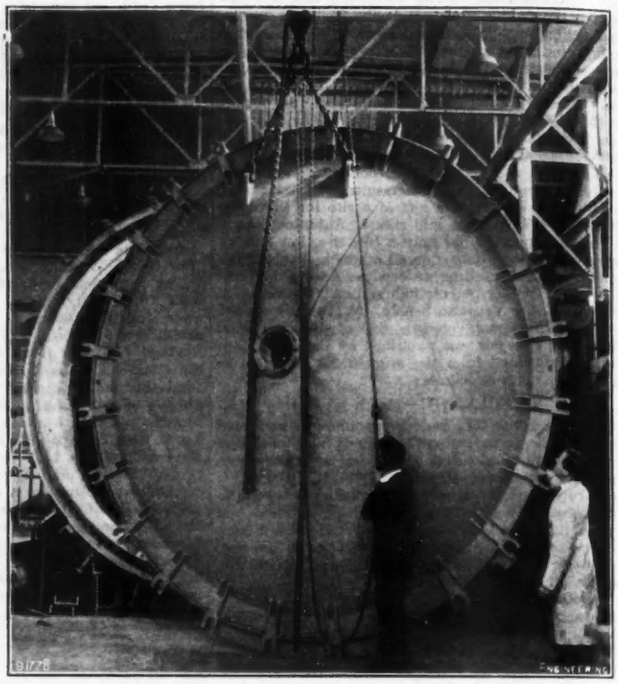

FIG. 2. REMOVABLE END OF CHAMBER.

HIGH-ALTITUDE TEST CHAMBER FOR AIRCRAFT.

ONE of the many problems facing the civil-aircraft designer is the development of suitable pressure cabins and pressurisation equipment that will enable jet-propelled aircraft to fly at the great heights necessary for their efficient operation. It is now generally accepted that, in the case of passenger aircraft, the cabin atmosphere should be maintained at a pressure not less than that equivalent to a height of 8,000 ft. The problems, however, are not confined to pressure only: other factors, such as humidity, temperature and apparent rate of climb have to be taken into account. Still further problems are concerned with the behaviour at high altitudes of the various aircraft components situated outside the fuselage, particularly those associated with the fuel system. Formerly the examination of pressurised fuselages and the associated equipment had to be carried out during flight, a method necessitating many hours of flying to achieve a few minutes work and which affords only a limited range of conditions during each flight. In order to dispense with this protracted and somewhat hazardous procedure, Messrs. de Havilland Aircraft Company Limited, Hatfield, Hertfordshire, have erected two test chambers, the larger of which is capable of accommodating a portion of a transport aircraft fuselage or a complete fighter fuselage, while the smaller chamber is used for testing fuels and fuel-system components under high-altitude conditions.

The larger chamber is illustrated in Fig. 1; externally, it has a length of 35 ft. and a diameter of 14 ft., the corresponding internal dimensions being 27 ft. and 12 ft., respectively. It is capable of being evacuated to a pressure equivalent to that at an altitude of 80,000 ft., while the internal temperature can be controlled within the limits of +40 deg. C. and −70 deg. C. The chamber is of all-welded construction and has been built from steel plates $\frac{5}{8}$ in. in thickness. Both ends of the chamber are domed, one end being welded directly to the main shell and incorporating an air-lock to give access to the chamber when partially evacuated, while the other end is detachable for the insertion of the test specimens. The detachable end is illustrated in Fig. 2, and the air-lock is shown in Fig. 3; as will be seen from Fig. 2, the detachable portion is held to the main shell by hinged bolts and it is lifted clear from the chamber by an overhead gantry. The chamber is provided with observation windows consisting of two glass panels separated by an air space, which contains a calcium-chloride desiccant. In addition, other panels similar to the observation windows, but with the glass replaced by single steel plates, are fitted for admitting instrument and electrical connections into the chamber through pressure-tight joints; one of these panels is shown in detail in Fig. 4, opposite.

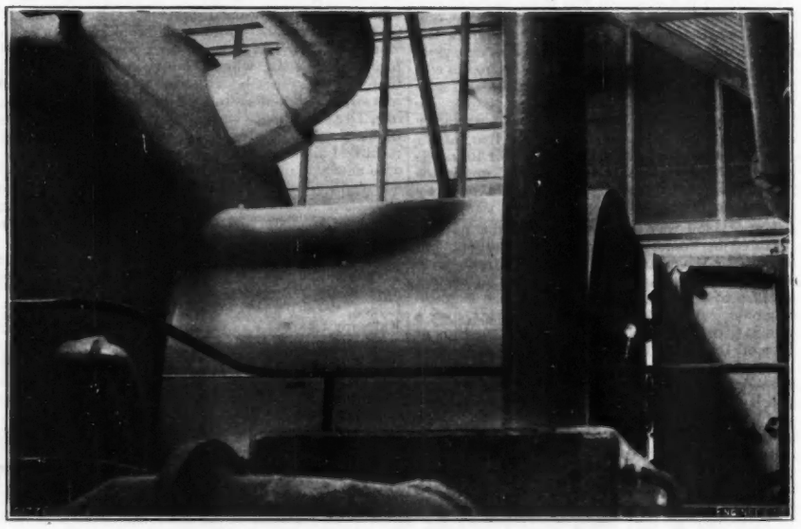

FIG. 3. ENTRANCE TO CHAMBER AND AIR-LOCK.

The chamber is evacuated by the electrically-driven double-acting single-cylinder vacuum pump, illustrated in Fig. 5, opposite, which was supplied by Messrs. Reavell and Company Limited, Ipswich; the capacity of the pump is 2,000 cub. ft. a minute. The chamber is evacuated through motor-driven control valves operated remotely from the main control panel, the valves giving positive and fine control so that conditions simulating any altitude up to 80,000 ft. can be reproduced and the rate of climb governed as required. To bring the chamber back to atmospheric pressure, filtered air is drawn in through remotely-controlled motor-driven valves similar to those in the vacuum system; a group of control valves in the vacuum system is shown in Fig. 6, on page 516.

A refrigeration system in which methylated spirit is sprayed over crushed blocks of solid carbon dioxide is provided, the equipment having been supplied by Messrs. J. and E. Hall, Limited, Dartford, Kent. The blocks of carbon dioxide are fed through an ice crusher into a large insulated cooling tank, in the bottom of which is a sump containing methylated spirit; the cooling tank with the ice-crusher above it is illustrated in Fig. 7, on page 516. The spirit is pumped by a centrifugal pump from the sump through gilled-tube coolers situated in the fixed end of the chamber, and then back to a spray fitted to the top of the cooling tank, the spirit from the spray passing down through the crushed carbon dioxide, where it is cooled, and collected in the sump for recirculation; by this method a spirit temperature of −76 deg. C. is obtained at the coolers in the chamber. The air in the

HIGH-ALTITUDE TEST CHAMBER FOR AIRCRAFT.

MESSRS. DE HAVILLAND AIRCRAFT COMPANY LIMITED, HATFIELD.

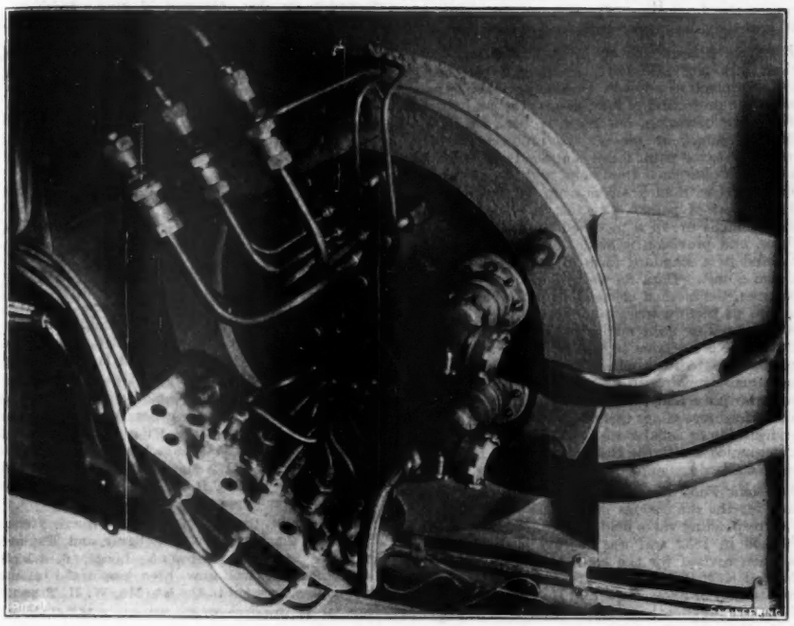

FIG. 4. PANEL FOR ADMITTING INSTRUMENT LEADS.

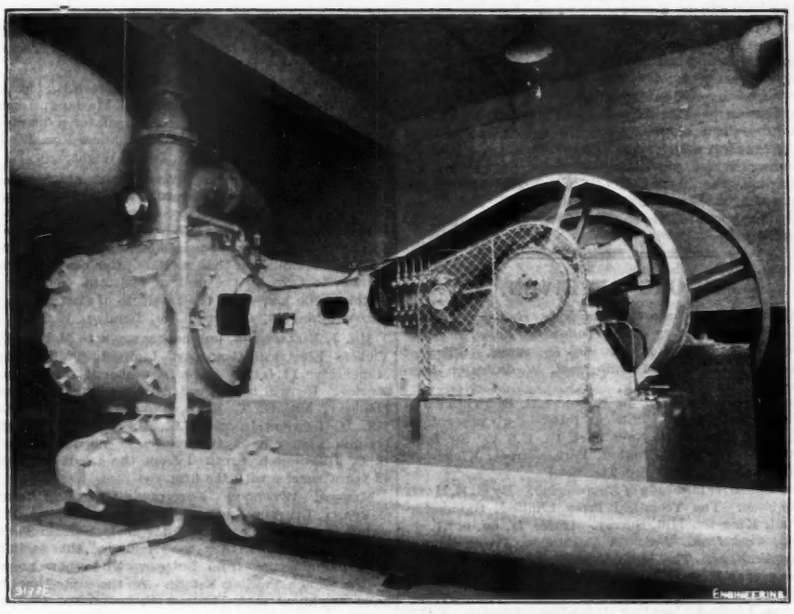

FIG. 5. DOUBLE-ACTING VACUUM PUMP.

chamber is circulated over the coolers and distributed by two electrically-driven fans, each of which has a capacity of 15,500 cub. ft. a minute. The chamber can be cooled from normal atmospheric temperature down to —60 deg. C. in 80 minutes, and 80,000 B.Th.U. per hour can be absorbed during tests. Any intermediate temperature can be obtained by controlling the rate at which the spirit is circulated and by varying the feed of carbon dioxide to the cooling tank. When refrigeration is to be used, the air entering the chamber is passed through a small mechanically-refrigerated cooler so as to extract the surplus moisture and thereby prevent the formation of ice within the chamber during tests. For the simulation of tropical conditions, the fans circulate the air in the chamber through steam heaters, a temperature of 40 deg. C. being obtainable by these means. The chamber is insulated with a lining of kapok, which, in turn, is faced with cedar-wood boarding; Fig. 8, on page 516, shows the insulation being fitted during erection. The cooling tank and service pipes are insulated with compressed cork and the heavily-lagged return trunk can be seen in Fig. 3 just above the inner end of the air-lock.

When full-scale tests on cabin pressurising and air conditioning are carried out, the compressed air which, during flight, would be supplied by the cabin blowers, is taken from the factory compressed-air main. This air, however, is first passed through filters and water-traps, then through a cooler to condense and remove excess moisture, and finally through a heater to restore it to the required temperature. Instruments are provided for measuring the flow, temperature and pressure of this air, thus enabling a variable quantity of air to be passed into the cabin at any desired temperature, pressure and humidity.

The tests carried out in the chamber are controlled from a main panel, a general view of which is given in Fig. 9, on page 516. The control panel, however, is divided into two parts; a permanent section on which such items as the push-button controls for operating the motor-driven valves in the vacuum and refrigeration systems, indicating lights and those instruments showing pressure, rate of climb, temperature, etc., are fitted; and a detachable section on which any group of instruments concerned with the particular test in progress can be mounted. Two systems are provided for communication between the observers inside the chamber and the control panel, namely, a standard aircraft inter-communication set and a two-way loudspeaker system. In the latter system, the observers inside the chamber have priority, and, in an emergency, can override the controller. In addition, the observers are provided with oxygen, electrically-heated clothing and a warning system which consists of a series of emergency switches placed at strategic points in the chamber which operate a red light on the main control panel. In order that aircraft-type electrical equipment may be used throughout, a 24-volt direct-current supply is available, as well as 400-volt and 230-volt alternating-current supplies.

In its main essentials, the fuel-testing chamber is similar to the chamber just described, but it is, of course, considerably smaller, the internal dimensions being 7 ft. long by 6 ft. 6 in. diameter. It is provided with windows and instrument-inlet panels, as for the main chamber, and is connected to the same vacuum pump. The control of the vacuum is similar to the method used on the larger chamber, but in this case the valves are operated manually from a control point beside the chamber. The access door is clamped to the chamber in a manner similar to that employed for the larger chamber, but the door is hinged to the main casing. To prevent fuel vapour from test rigs in the chamber from entering the pump, a condensate collector has been fitted into the vacuum line between the chamber and the pump, the collector consisting of a metal tank filled with cooling coils which are cooled by a small carbon-dioxide and methylated spirit plant. At present the chamber is not refrigerated, but provision has been made for this to be done at a later date.

Two cylindrical tanks, each 6 ft. 6 in. high and 3 ft. in diameter, are situated beside the chamber and these are used to receive fuel from aircraft-type fuel tanks situated inside the chamber during fuel-pump tests. The two tanks are connected to the chamber by balance pipes, so that they are always at the same internal pressure as the chamber. A steam calorifier is provided for heating the fuel, and the fuel pumps are driven by an electric motor.

The complete equipment is housed in a new building which has been erected for the purpose. The bay for the main chamber and its associated equipment is 80 ft. long and 46 ft. wide, and beside this is another bay, 54 ft. long and 22 ft. wide, for accommodating the fuel-testing equipment, the vacuum pump being housed in a separate room 26 ft. long by 22 ft. wide. Another floor is situated over the fuel-test bay and the vacuum pump room, and this is used to accommodate an insulated storage bin for the solid carbon dioxide, spare test equipment, a room for the electrical-control gear and an office. Two storage tanks, one for petrol and the other for paraffin, each having a capacity of 1,000 gallons, are located underground and outside the building, while a third tank of 500 gallons capacity provides storage for the methylated spirit. Obviously, strict precautions against fire have had to be taken, and the fuel-test bay is surrounded by fireproof walls and all interior access doors are of the double fireproof type. A comprehensive ventilation system has been installed, including ventilation of individual test rigs and a carbon-dioxide extinguisher system, having both automatic and manual control, covers the whole area. As a further precaution, all rigs are connected to the underground storage tanks through automatic jettisoning valves.

All the equipment described above is now installed and in use. The first trials of the evacuating system were carried out at the end of January, 1947, and the first run of the refrigerating system was made early in February. Since then, the instrument equipment has been completed and the first tests on aircraft components were commenced in April of this year. It may be noted, in conclusion, that the whole plant was installed and in operation less than a year from the date of its inception.

STANDARD RANGE OF BEARINGS.—Messrs. The Glacier Metal Company, Limited, Wembley, Middlesex, are now producing a standard range of thin-walled steel-backed white-metal lined half bearings. It has not proved possible, however, to standardise all the bearing dimensions, as this would have limited the scope of designers too severely. The only dimension standardised, therefore, is the outside diameter, and the oil holes, gutterways, etc., can be located in accordance with requirements.

RESEARCH AND DEVELOPMENT ORGANISATION.

Most large industrial concerns possess their own research departments, and, during the past few decades, many research associations which confine their activities to particular industries or types of products have been established. The objects of a new organisation, known as the Amalgamated Research and Development Company, Limited, however, are different, in that the resources of this company are available to the small industrial firm, whatever its manufacturing activity, and also to the independent inventor of limited means. The company aim to develop, through the initiative of their own employees or from suggestions and commissions from outside, new products for industry, which may involve the development of new processes and new designs, and also to obtain, by co-operative effort between scientific investigators, engineers and business men, a more efficient application of scientific knowledge. Initially the organisation has been set up with the financial backing of Associated British Engineering, Limited; Messrs. Dawnay, Day and Company, Limited, and General Mining Industries, Limited, of South Africa, but the shareholding interests, we understand, are likely to be extended to include industrialists in other parts of the British Empire.

It is expected that, to begin with, the work undertaken by the company will be devoted, in the main, to increase the activities of the engineering firms with whom it is associated. As indicated above, however, one of the main objects of the enterprise is to encourage independent inventors. It is emphasised that an inventor whose idea is developed and eventually marketed by the company will be protected by an agreement assuring him of a percentage of the eventual profits accruing from the exploitation of his invention; this percentage is to be arrived at by mutual consent. The directors of the company are Mr. R. P. Fraser, O.B.E., A.R.C.Sc., D.I.C., the Hon. A. C. Geddes, O.B.E., M.C., A.R.S.M., B.Sc., Mr. C. L. Hill and Mr. J. M. Hopkinson. At present, the firm's engineering and chemical-engineering shops and laboratories are housed at a works at Staines, recently acquired from Lagonda Limited, by an affiliated company. The registered offices of the Amalgamated Research and Development Company, Limited, are at Duke's-court, 32, Duke-street, St. James's, London, S.W.1

Institution of Water Engineers.—The fifty-second winter meeting and thirty-seventh annual meeting of the Institution of Water Engineers will be held at the Institution of Civil Engineers, Great George-street, London, S.W.1, on Thursday, December 4, at 10 a.m. After the transaction of the official business, four papers will be introduced by their respective authors and presented for discussion, namely, "The Spring Floods of 1947," by Messrs. B. Howorth, N. A. Mowbray, W. H. Haile and G. Cubley Crowther; "Biology of Eye Brook Reservoir: an Account Covering the First Seven Years of a Large Shallow Reservoir in the East Midlands," by Mr. G. C. S. Oliver; "Percolation in the Chalk," by Mr. Charles F. Lapworth; and "Hydraulic Investigations of Water Distribution Systems in Field and Office," by Professor Gordon M. Fair. The last-mentioned paper will be presented, on behalf of the author, by Mr. W. M. Lloyd Roberts. There will be a luncheon interval at 12.30 p.m. and the discussion will be resumed at 2 p.m. Tickets of admission and advance copies of the papers are obtainable from the secretary of the Institution, Mr. A. T. Hobbs, Parliament-mansions, Abbey Orchard-street, London, S.W.1.

The Electrical Industries Benevolent Association.—Although the Institution of Electrical Engineers, in common with other major engineering institutions, operates a benevolent fund for the benefit of such of its members, or their dependants, as may encounter financial misfortune, there are great numbers of employees in the electrical industry who do not fall within its provisions. It is the province of the Electrical Industries Benevolent Association to assist, when possible, the non-manual part of the latter class. Its activities extend from the chief engineer to the junior typist. Contact is naturally made with other organisations when individuals have claims on more than one fund, but that the work of the association is necessary is shown by the fact that over 80 per cent. of the persons who have been assisted had no claim on any other fund. It is the practice to devote much care and attention, in the way of personal service and instructed advice, to applicants, attention of this kind frequently being as valuable as financial assistance. The Year Book, 1947, of the Association shows continually increasing money grants over the years, the sum for 1946 amounting to 16,134*l*. The work of the Association may be commended to all connected in any way with the electrical industry. The address is 32, Old Burlington-street, London, W.1.

BRITISH STANDARD SPECIFICATIONS.

The following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, at the price quoted at the end of each paragraph.

Protective Schemes for Steel.—A provisional specification, B.S. No. 1391-1947, covering a performance test for protective schemes embracing stoving paints used in the protection of light-gauge steel and wrought iron against corrosion, has recently been issued. Its scope is limited, at present, to protective schemes in which a stoved paint finish is applied over a metallic coating or a phosphate treatment, and the specification is concerned with such schemes up to, and including, the first coat of paint. The test is made on special test specimens or, in a modified form, on the actual articles, and provision is made for the samples to be subjected to a standard form of damage before they undergo a test. Data on the preparation of the test specimens, the method of conducting the test, and the standard of performance required, are included. The specification has been made provisional deliberately, and its issue is intended to lead to the accumulation of experience as to its applicability. It is proposed to issue a questionnaire within twelve months requesting those who have had occasion to use the test to give information regarding their experience. Users who may feel able to collaborate in this way are requested to communicate with the British Standards Institution. [Price 2*s*. 6*d*., postage included.]

Electronic Valve Bases, Caps and Holders.—A specification for the dimensions of wireless-valve bases and the corresponding valve holders, B.S. No. 448, was first published in 1932 and was revised in 1936. It has now been revised for the second time and has been published as "British Standard Specification for the Compatibility of Bases, Caps, and Holders for Electronic Valves, including cathode-ray tubes and photo-electric cells." Whereas the 1932 edition dealt only with the dimensions of British four-pin and five-pin valve bases and the corresponding valve holders, the scope of the 1936 edition was extended to include the dimensions of the British seven- and nine-pin bases and holders. In the present, 1947, revision of the specification, the scope has been further extended to include many other types of valve base which have been introduced in the interim. The first section of the specification deals with bases and holders in general, and subsequent sections cover the dimensions of, and the gauges for, many types of valve bases and holders, including British pin bases with four, five, seven and nine pins, the Mazda Octal base, the Octal base, 12-pin spigot base, 12-contact key-base, B3G base, B9G base, and B7G base. [Price 7*s*. 6*d*., postage included.]

BOOKS RECEIVED.

Scientific and Technical Research in British Industry. A Statistical Survey by the Industrial Research Secretariat of the Federation of British Industries. Offices of the Federation, 21, Tothill-street, Westminster, London, S.W.1. [Price 1*s*.]

Photographic Surveying. By Colonel B. B. Talley and Paul H. Robbins. Pitman Publishing Corporation, 2, West 45th-street, New York 19, U.S.A. Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, London, W.C.2. [Price 24*s*. net.]

Foundations for the Study of Engineering. By G. E. Hall. Re-issue. The Technical Press Limited, Gloucester-road, Kingston Hill, Surrey. [Price 7*s*. 6*d*. net.]

Nickel Cast Iron. Data on Production, Properties and Applications. The Mond Nickel Company, Limited, Grosvenor House, Park-lane, London, W.1. [Free.]

Plastics Manual. By H.R. Fleck. Published for Temple Press Limited, Bowling Green-lane, London, E.C.1, by the English Universities Press Limited, St. Paul's House, Warwick-square, London, E.C.4. [Price 15*s*. net.]

British Compressed Air Society. Handbook on Pneumatic Equipment. Offices of the Society, 94-98, Petty France, Westminster, London, S.W.1. [Price 20*s*.]

Radio Engineering. Volume I. By Dr. E. K. Sandeman. Chapman and Hall Limited, 37, Essex-street, Strand, London, W.C.2. [Price 45*s*. net.]

Design This Day. The Technique of Order in the Machine Age. By Walter Dorwin Teague. The Studio Limited, 66, Chandos-place, Strand, London, W.C.2. [Price 35*s*. net.]

Le Formulaire des Engrenages. Traité pratique pour le calcul, le tracé et l'exécution des Engrenages. By Charles Macabrey. Third edition. Dunod, 92, rue Bonaparte, Paris (VIe.). [Price 750 francs.]

The Maintenance Electrician's Handbook. By D. J. Hartshorne. Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, London, W.C.2. [Price 8*s*. 6*d*. net.]

PERSONAL.

At the annual general meeting of the Central Board of the Shipbuilding Employers' Federation, held in Edinburgh, on November 21, Sir Wilfrid Ayre, J.P., M.I.N.A., was elected President for the coming year, in succession to Mr. George Barrie, M.I.N.A. Mr. Frank W. Dugdale, B.Sc., M.I.N.A., M.I.Mar.E., thus becomes senior vice-president, and Sir Lawrie Edwards, M.I.N.A., and Mr. Charles Connell, M.A., M.I.N.A., were also appointed vice-presidents. Mr. V. S. Mangham, M.I.Mar.E., was elected chairman and Mr. R. S. Chipchase, C.B.E., M.I.N.A., vice-chairman, of the Conference and Works Board.

Following his resignation from the chairmanship of the British Overseas Airways Corporation, Lord Knollys, K.C.M.G., M.B.E., D.F.C., has relinquished his position on the Council of the Air Registration Board, Brettenham House, Lancaster-place, Strand, London, W.C.2. Mr. Whitney Straight, C.B.E., M.C., D.F.C., has been elected to fill the vacancy on the Council of the Air Registration Board.

Mr. E. A. Evans, M.I.Mech.E., F.Inst.Pet., has been nominated President-designate of the Institute of Petroleum, 26, Portland-place, London, W.1, for the session 1948-49. Mr. Evans is chief chemist to the Wakefield group of companies and is chairman of the Motor Industry Research Association.

In recognition of the valuable services performed by the Royal Electrical and Mechanical Engineers during the recent war, the King has approved that, in future, this Corps shall have the honour of providing an Aide-de-Camp to His Majesty. Colonel (T./Brigadier) C. Campbell, C.B.E., M.I.Mech.E., is the first R.E.M.E. officer appointed in this capacity.

Mr. George Caton, M.I.E.E., formerly technical director of the Yorkshire Switchgear and Engineering Company, Limited, Meanwood, Leeds, 6, which he joined in 1938, has now been appointed managing director, in succession to the late Mr. W. H. Turner.

Mr. P. G. Bhagat, B.Sc. (Glas.), A.M.I.C.E., M.I.E. (India), has taken over the post of Director-General, India Store Department, at present located at Blackpool, from Mr. W. F. West, C.I.E., with effect from November 6.

Mr. T. S. Harker, B.Sc.(Eng.) (Lond.), A.M.I.Mech.E., has been appointed principal of Wimbledon Technical College, London, S.W.19.

Mr. Walter Browning, A.M.I.Mech.E., formerly works manager, Messrs. Short and Harland, Limited, Queen's Island, Belfast, has been appointed a director of, and general manager to, Messrs. Saunders-Roe, Limited, Columbine Yard, East Cowes, Isle of Wight.

Mr. G. Lambert, for several years chief assistant to the secretary of the Institute of Marine Engineers, has been appointed assistant secretary to the Institute of British Foundrymen, St. John-street Chambers, Deansgate, Manchester, 3, in succession to Mr. John Bolton, who has relinquished that position after nearly 10 years' service, to take up the post of assistant secretary and editor of the journal of the Institute of Cost and Works Accountants, 23, Queen-square, London, W.C.1.

Mr. J. Billington, purchasing agent to Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, is to retire on December 31, after 45 years' service. He will be succeeded by the present contracts manager, Mr. G. T. King, and Mr. King's assistant, Mr. H. Lawson-Jones, M.C., B.Sc. (Eng.), will then become manager of the contracts department. Mr. B. C. Johnson has retired from the Leeds office after 42 years' service with the firm.

Messrs. Wycliffe Foundry and Engineering Company, Limited, Lutterworth, Rugby, announce that, owing to increasing demand for their Varatio Positive change-speed gears, they have removed this section of their manufacture from Lutterworth to new premises on the Slough Trading Estate. At the same time, they have combined with Higham Engineering Company, Limited, and production of the Varatio gearbox will be carried on in conjunction with the Higham Strateline speed reducer by Varatio Strateline Gears, Limited, 278, Aberdeen-avenue, Trading Estate, Slough, Buckinghamshire. (Telephone: Slough 22391-2.)

The Wellman Smith Owen Engineering Corporation, Limited, have removed their head office from Victoria Station House to more commodious premises at Parnell House (opposite Victoria Station), London, S.W.1. The telephone numbers and telegraphic address remain unaltered except that the telephone number of the furnace construction department is VICtoria 9684-5

Senior Economisers Limited: Erratum.—We regret that, on page 442, *ante*, the name Screen Economisers Limited was given as the firm which Sir George Usher, Mr. F. G. Penny, M.I.C.E., M.I.E.E., the Hon. Douglas Vivian and Mr. R. Armstrong had joined as directors. The name, of course, should have been Senior Economisers Limited.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel.—The improved outputs of recent weeks at the Scottish works were maintained last week. For technical and other reasons, the tonnage was not quite up to the record-breaking weekly level reached in August, and the dearth of steel scrap again militated against maximum production in some places. Such success as makers have had in maintaining the present high level of output, unfortunately, has been at the expense and risk of reducing their reserve stocks of pig iron and steel scrap to the danger point. It has been said that reserves in hand at the moment are lower than they have been at any time. Scrap reserves are believed to be less than a full week's supply, while at some works the scrap problem has reduced the number of melting furnaces that can be used. Plates and sections again constitute the bulk of the output and demand. Thin plates are extremely scarce and many users have had to accept reduced deliveries, though the tonnages are generally sufficient to meet all urgent business. Shipyard work is not affected by the general scarcity, beyond the fact that only immediate needs can be catered for. Re-rollers are relying on any suitable parcels of discard and scrap they can find to eke out their ration of billets, but manage in this way to prevent their orders and contracts from falling behind any further. Sheetmakers are short of bars, and the restricted rolling programme has to be adhered to. Some increase in the export quotas for steel products is expected to be announced shortly for Period 1, 1948. Transport is difficult, but greater use of road services has enabled makers to overcome the shortage of railway transport facilities.

Scottish Coal.—The rise in output secured during the past fortnight has infused new hope into the market, and with current deliveries rather tending to exceed the regular quotas of users, there is every prospect of winter stocks being sufficiently consolidated to prevent any repetition of the difficulties experienced by users last winter. Given a normal winter, industrial needs should be reasonably well covered. Public-utility undertakings in Scotland have not yet reached their full stock requirements, and some English districts are rather better placed by comparison, but it is generally recognised that Scotland's winter problem is not likely to become as difficult as England's might well be if last winter's weather should recur. House coal receipts have expanded satisfactorily and depot stocks are increasing steadily. Consumers' stocks are nearly half as large again as they were a year ago, and output is now at least 10,000 tons a week higher than it was at that time. If current outputs are maintained, it is thought that by next spring Scotland may be able to resume exports on a much better scale than at present.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—There was a set-back in production on the second Saturday morning shift worked in South Wales as compared with the first. Official figures showed that, in the whole of the South-Western Division, production on the second Saturday morning amounted to 35,057 tons, of which all but about 700 tons was produced in South Wales and Monmouthshire. It compared with 48,648 tons in the previous week. The arrangements for extra work have been under review by the Divisional Coal Board and representatives of the South Wales area of the National Union of Mineworkers. It was stated officially that it had been agreed to continue the arrangement for a further period of two weeks at all collieries where it had been decided to extend the working hours. The meeting welcomed the results achieved but called for still further increased efforts. The small surplus of coal that became available on the Welsh steam-coal market last week was quickly disposed of. A very active home trade provided a ready outlet for almost the whole of current productions and orders in hand were sufficient to earmark the bulk of outputs for some months to come. It was announced during the week that 4,000 tons of Welsh anthracite had been made available for shipment to Tasmania, but apart from this, export trade was again confined to the Canadian and Eireann trades. Following the removal of some of the restrictions on ships' bunkers, there has been an increased demand for these and a large part of the extra coal available was absorbed in this way. Cokes and patent fuel were very difficult to secure.

Swansea Steel-Sheet Industry.—The market report issued by the Incorporated Swansea Exchange states that, last week, business in tin-plate was steady. The demand was good but the volume of business transacted was not as heavy as expected. In the home market, business was somewhat quiet and the quantities sold were on a reduced scale. Steel sheets continued to have a huge demand which is in excess of the capacity of the mills. Iron and steel scrap is in demand and, as a result of publicity, the deliveries to consumers have improved.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Some improvement in steel production has taken place, but the output still falls short of requirements. This is due to lack of sufficient materials in the form of coke, pig-iron and scrap. Pig-iron makers complain of irregular deliveries of coke, partly due to inadequate railway transport caused by shortage of wagons. The shortage of supplies of iron and steel scrap for re-melting imposes a strain on pig-iron supplies; efforts to remedy the position are being made by a national appeal for scrap. It is computed that the staggered-hours system of working is effecting a saving of 25 per cent. in power. A mission from the English Steel Corporation, including technicians from Sheffield and Darlington, is on its way to the United States to investigate particularly the method of manufacturing large cast-steel back-up rolls for continuous rolling mills. Information will also be sought on specialised types of cast-steel bogies and underframe parts used in the construction of rolling stock, as well as automatic couplers for use on rolling stock abroad and for the new types of mine cars to be introduced into British coal mines. The mission is expected to be in America for several months.

South Yorkshire Coal Trade.—Longer working weeks in the majority of pits have provided much-needed additional supplies of coal which have been quickly disposed of. Steps have been taken to provide additional coal for industry, and house-coal merchants have been advised that it may not be possible to provide full allocations of house coal during November, December and January; 12 cwt. instead of 15, is expected to be the maximum available per household. To conserve the use of railway wagons, house-coal merchants are to send lorries and bagging men to the pit-heads, where coal will be bagged ready for retail delivery. Merchants have been told that house-coal supplies must be taken from near-by pits to reduce rail haulage.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Tees-side iron and steel manufacturers are turning out an increasing tonnage, but available parcels still fall short of customers' requirements. Arrears of deliveries are heavy and the shortage of wagons continues to prevent the clearance of accumulation of commodities at works. The position with regard to rolling-stock supply, however, is rather better than of late, but many more trucks are urgently needed and much quicker handling of wagons is required to deal with material awaiting rail transport. The yield of Cleveland ironstone continues to be disappointing. Compared with a weekly average of 18,000 tons last year, the September output averaged only 14,700 tons per week. The shrinkage is attributable chiefly to the shortage of man power. Iron and steel scrap is still wanted in much larger quantities than merchants can provide but substantial parcels from Germany are expected in the near future. Imports of foreign iron ores are being maintained at a satisfactory level. The better fuel supply has enabled an additional blast-furnace to be lighted up and another stack may be blown in shortly.

Foundry and Basic Iron.—The meagre supplies of ordinary foundry pig iron and the continued shortage of heavy cast-iron scrap are seriously retarding the manufacture of several commodities urgently needed in large quantities; there is a persistent demand for a larger production of light castings. Basic blast-furnaces are supplying substantial parcels of iron for Tees-side works.

Hematite, Low Phosphorus and Refined Iron.—East-Coast hematite is in strong request. Makers are dealing adequately with the actual needs of regular customers but are unable to comply with increasing demands for larger deliveries to enable stocks to be built up. The outputs of low- and medium-phosphorus grades of iron do not cover users' urgent requirements. All distributable parcels of refined iron are readily taken up.

Manufactured Iron and Steel.—Semi-finished and finished iron manufacturers have sufficient work in hand to ensure great activity at the plants for as far ahead as the acceptance of orders is permitted, and buyers are anxious to discuss arrangements for further supplies. Steel producers have very heavy bookings and only by using the very moderate reserve stocks of pig iron, scrap and other requisite materials can they maintain outputs at the present high level. Works turning out steel semies are as busily occupied as circumstances permit but are not yet providing sufficient tonnage to cover the heavy requirements of users. The production of ingots is meeting consumers' actual needs, but the demand continues for larger supplies of billets, blooms and sheet bars for the re-rolling mills. All classes of finished steel are still in heavy demand. Shipbuilders are taking up their full quotas, as also are buyers of black and galvanised sheets. The demand for railway requisites absorbs supplies as they become available.

NOTICES OF MEETINGS.

It is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

SOCIETY OF ENGINEERS.—Monday, December 1, 5.30 p.m., Geological Society, Burlington House, Piccadilly, W.1. "Water Supply Engineering," by Mr. Bernard Payne.

INSTITUTION OF MECHANICAL ENGINEERS.—*North-Eastern Branch:* Monday, December 1, 6 p.m., Neville Hall, Newcastle-upon-Tyne. "The Norwich Heat Pump," by Mr. J. A. Sumner. "The Air-Cycle Heat Pump," by Mr. T. F. Thomas. *London Graduates' Section:* Thursday, December 4, 6.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Electronics for the Engineer," by Mr. K. M. Fantom. *North-Western Branch:* Thursday, December 4, 6.45 p.m., Engineers' Club, Manchester. Re-delivery of Presidential Address, by Lord Dudley Gordon. *Institution:* Friday, December 5, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Fuel and Combustion Systems for the Aero-Gas Turbine," by Dr. E. A. Watson. AUTOMOBILE DIVISION. Tuesday, December 2, 6 p.m., Storey's-gate, St. James's Park, S.W.1. "Recent Developments in Transmissions," by Professor E. G. M'Ewen.

INSTITUTION OF ELECTRICAL ENGINEERS.—*South Midland Centre:* Monday, December 1, 6 p.m., James Watt Institute, Birmingham. "Neutral Earthing of Three-Phase Systems," by Messrs. J. R. Mortlock and C. M. Dobson. *Mersey Centre:* Monday, December 1, 6.30 p.m., Royal Institution, Colquitt-street, Liverpool. "Electrical Technique in the Service of Other Industries," by Messrs. H. Cobden Turner and G. M. Tomlin. Also at the *Southern Centre:* Saturday, December 6, 2.30 p.m., Pavilion, Bournemouth. *North-Western Centre:* Tuesday, December 2, 6 p.m., Engineers' Club, Manchester. "Electric Traction on the Southern Railway," by Mr. C. M. Cock. *North Midland Centre:* Tuesday, December 2, 6.30 p.m., Electricity Dept., Whitehall-road, Leeds. "Irish Electricity Supply System," by Messrs. A. Burke, R. C. Cuffe and W. O'Neill. *East Midland Centre:* Tuesday, December 2, 6.30 p.m., Loughborough College, Loughborough. "Electricity Supply as a Consumer Service," by Mr. C. T. Melling. *Radio Section:* Wednesday, December 3, 5.30 p.m., Victoria-embankment, W.C.2. "High-Power Broadcast Transmitter Units," by Messrs. T. C. Macnamara, A. B. Howe and P. A. T. Bevan. *Institution:* Thursday, December 4, 5.30 p.m., Victoria-embankment, W.C.2. Meeting with PHYSICAL SOCIETY. "Speech Communication under Conditions of Deafness or Loud Noise," by Dr. W. G. Radley. *Measurements Section:* Friday, December 5, 5.30 p.m., Victoria-embankment, W.C.2. Discussion on "Economics of Metering."

INSTITUTION OF PRODUCTION ENGINEERS.—*Yorkshire Section:* Monday, December 1, 6.30 p.m., Hotel Metropole, Leeds. Symposium on "Foremanship." *Birmingham Section:* Friday, December 5, 6.30 p.m., Imperial Hotel, Birmingham. Discussion on "Industrial Lighting."

INSTITUTION OF CIVIL ENGINEERS.—*Maritime Engineering Division:* Tuesday, December 2, 5.30 p.m., Great George-street, S.W.1. "Heysham Jetty," by Professor A. L. L. Baker. *Newcastle Association:* Tuesday, December 2, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "Light Alloys as Structural Materials," by Mr. W. Muckle.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, December 2, 6.30 p.m., 39, Elmbank-crescent, Glasgow. "Voyage of Tanker 'Niso' Under Winter Conditions," by Messrs. G. M. Boyd, F. B. Bull and K. J. Pascoe.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Wednesday, December 3, 6 p.m., Institution of Civil Engineers, Great George-street, S.W.1. "Moisture Retention," by Dr. A. M. J. Janser.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Northern Counties Branch:* Wednesday, December 3, 6.30 p.m., Neville Hall, Newcastle-upon-Tyne. "Deep Foundations," by Mr. L. Scott White. Also on Thursday, December 4, 6.30 p.m., Cleveland Scientific Institute, Middlesbrough. *Western Counties Branch:* Friday, December 5, 6.15 p.m., Merchant Venturers' College, Bristol. "Lateral Stability of Beams," by Professor A. G. Pugsley.

ROYAL AERONAUTICAL SOCIETY.—Thursday, December 4, 6 p.m., Institution of Civil Engineers, Great George-street, S.W.1. "Problems Facing Civil Airline Operations," by Mr. N. E. Rowe.

ROYAL STATISTICAL SOCIETY.—*Industrial Applications Section:* Friday, December 5, 6 p.m., 2, Savoy-hill, W.C.2. "Mathematics Division of the N.P.L.," by Mr. E. C. Fieller.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, December 5, 6.30 p.m., 39, Victoria-street, S.W.1. Films on "Oil Production," introduced by Mr. W. M. Hurrell.

HIGH-ALTITUDE TEST CHAMBER FOR AIRCRAFT.

MESSRS. DE HAVILLAND AIRCRAFT COMPANY LIMITED, HATFIELD.

(For Description, see Page 512.)

FIG. 7. MAIN COOLING TANK AND ICE-CRUSHING PLANT.

FIG. 9. MAIN CONTROL PANEL.

FIG. 6. GROUP OF MOTOR-DRIVEN CONTROL VALVES.

FIG. 8. APPLYING LAGGING TO CHAMBER DURING ERECTION.

ENGINEERING.

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ENGINEERING

FRIDAY, NOVEMBER 28, 1947.

VOL. 164. No. 4270.

MACHINERY FOR CARGO VESSELS.

ALTHOUGH it might have been expected that the war would simplify greatly the shipowner's recurrent problem of selecting the most suitable type of propelling machinery for cargo vessels, there is still an almost embarrassing variety available, even without the gas turbine, which, although in its infancy, bids fair to become a keen rival to the steam turbine and the Diesel engine. The issue is more complicated than it would appear at first sight, moreover, as the steam turbine can be arranged to drive either through mechanical or electrical gearing, while the Diesel may be coupled directly to the propeller shafting, may drive through reduction gearing, or, as in the case of the turbine, employ electrical transmission; and, presumably, all these methods, except the direct drive, will be applicable to the gas turbine also before many years have passed. The Institute of Marine Engineers was on safe ground, therefore, in arranging the symposium of papers on "The Engining of Cargo Vessels of High Power," which was held in London on November 11 and 12. Six papers were read, the types of main propelling machinery covered being the well-tried geared turbine, the direct-coupled Diesel engine, the geared Diesel, the Diesel-electric system, the turbo-electric drive, and the gas turbine. It will be noted from this list that a notable absentee was the steam reciprocating engine; possibly this was a sign of the times, though the reciprocating engine is by no means dead, at any rate, for the smaller-powered cargo vessels, and in conjunction with exhaust turbines.

According to the terms of reference laid down by the Superintendent Engineers' Committee of the Institute, who organised the symposium, the authors were restricted to machinery installations of 7,500 shaft horse-power on a single shaft and 13,000 shaft horse-power on either one or two shafts, and were to state fuel consumptions, machinery weights and space occupied for both main and auxiliary machinery, etc., to permit comparisons to be made between the various types. It is obvious, however, that such comparisons can be only approximate unless the various designs are worked out in detail for a vessel employed on a specified duty; many other factors, such as type of cargo, length of voyage, bunkerage, port facilities, speed, etc., have to be taken into account. Mr. C. C. Pounder, who championed the cause of both the directly-coupled and the geared Diesel engine, went farther in criticising the terms of reference of the symposium, pointing out that "a machinery comparison should take into account machinery weights, plus weights of seatings, plus bunker-steel weights, plus weight of bunkers for any prescribed length of voyage," because "this is what the shipowner is compelled to buy, and what he has to carry along in his ship, to ensure its propulsion." It would be incorrect to assume, therefore, that the results as they stood would provide a true weight-and-space comparison for prime movers. Other contributors supported this view in the course of the discussion.

There are, however, practical difficulties inherent in the preparation of papers on the lines mentioned above as the number of shipbuilders who construct their own propelling machinery is limited, particularly in the turbo-electric and Diesel-electric fields, and the Institute perhaps acted wisely in limiting the subject matter to engines of prescribed horse-powers. Obviously, each paper was limited to the machinery manufactured by one firm and it is more than likely that other firms making similar machinery will challenge wholeheartedly the figures quoted. Therefore, before any comparisons are made and conclusions drawn regarding the merits of the various projects, the danger of reaching such conclusions from only one example of each design should be borne in mind.

The first paper was presented by Dr. T. W. F. Brown, the Director of Research of Pametrada, who stated a very detailed case for the geared turbine. For the development of 7,500 shaft horse-power, a double reduction geared impulse turbine was suggested, using steam at 450 lb. per square inch and a temperature of 800 deg. F. A feature of this scheme was the provision of a hydraulic reversing and manœuvring system within the gearing, thus avoiding the need for an astern turbine. The total weight in the steam-up condition was given as 592 tons, the length of engine room, including boilers, as 46 ft. 6 in., and the fuel consumption for all purposes as 49 tons per 24 hours. Two schemes were put forward for the development of 13,000 shaft horse-power. The first consisted of compound impulse turbines, taking steam at 600 lb. per square inch and 900 deg. F. The high-pressure and low-pressure turbines would drive separate pinions of a double-reduction gear train coupled to a single propeller shaft. The total weight was given as 1,027 tons, the overall length of the engine room as 55 ft., and the fuel consumption for all purposes as 75·2 tons per 24 hours. Alternatively, Dr. Brown suggested the use of steam at a pressure of 1,500 lb. per square inch and a temperature of 800 deg. F., to be reheated twice between the turbine steam inlet and the condenser. The length of engine room would remain the same with this scheme, but the total weight would be increased to 1,038 tons; the fuel consumption, however, would be reduced to 72·3 tons per 24 hours for all purposes.

The paper on Diesel-electric propulsion which followed was presented jointly by Mr. J. G. Belsey, O.B.E., and Mr. J. G. Robinson, and proposed three different schemes for both the 7,500 and 13,000 s.h.p. outputs. For the former, they proposed either seven M.A.N. engines, each of 1,300 b.h.p., or five Ruston and Hornsby engines, each of 1,860 b.h.p., or three Sulzer engines, each of 2,975 b.h.p., each engine to drive a separate alternator. The weights were given as 574 tons, 669 tons and 611 tons, respectively, and the fuel consumptions for all purposes as 31·8 tons, 32·5 tons and 32·6 tons per 24 hours, the length of engine room remaining constant at 32 ft. Similar arrangements were suggested for the 13,000-s.h.p. arrangements, but in this case either seven M.A.N. engines of 2,200 h.p., or seven Ruston and Hornsby engines of 2,125 h.p., or five Sulzer engines of 2,975 h.p. were proposed. In these cases, the overall weights were given as 768 tons, 919 tons, and 865 tons, respectively, and the fuel consumptions as 54·8 tons, 56·5 tons and 56·3 tons per 24 hours, the length of engine room being 75 ft.

In presenting their proposals for turbo-electric drive, Mr. C. Wallace Saunders and Mr. T. Halliday Turner restricted themselves to information gained from practice, emphasising that all figures given

were derived from existing ships. Unfortunately, the authors confined their quoted weights to the main engines, saying that the weights for boilers, auxiliaries, shafting, etc., were the same as for the geared turbine. This statement ignored the fact that, by placing the motor aft in a separate compartment, a saving in weight could be obtained by the consequent elimination of the intermediate shafting and its supports, and rendered difficult any comparisons in weight.

Mr. J. Calderwood's presentation of the case for the gas turbine suffered somewhat from the lack of operating experience. Two proposals were made, however, for the 13,060-s.h.p. arrangement. The first employed reduction gearing in conjunction with a reversible propeller, and the other an electrical drive. In the first case, the weight of all components was calculated to be 939 tons, the length of engine room 57 ft. 9 in., and the overall consumption 62·7 tons per day. For electric drive, the weight was given as 952 tons, the length of engine room as 60 ft. 4 in. and the fuel consumption 65·7 tons. No concrete proposals were made for the 7,500-s.h.p. ship, as the author considered it unlikely that any shipowner would send a ship to sea with a single gas turbine during the early stages of development.

Finally, the case for the Diesel engine, both in the directly-coupled and geared forms, was put forward by Mr. C. C. Pounder. For the directly-coupled Diesel engine, he suggested the use of any one of four types of two-cycle engine for the development of 7,500 s.h.p. and any two of these engines for 13,000 s.h.p. Naturally, so liberal a choice involved a variety of possible weights, dimensions, and fuel consumptions, which need not be quoted in detail. While it is, perhaps, somewhat unorthodox to take an average of his figures for purposes of comparison, this method may serve to convey a general impression that is not too wide of the mark. With due recognition of the shortcomings of such average figures, therefore, it may be noted that they are: for 7,500 s.h.p. on a single shaft, overall weight 1,077 tons, length of engine room 65 ft. 6 in., and fuel consumption for all purposes, 33 tons per 24 hours; and for the twin-screw installations, overall weight 1,743 tons, length of engine room 68 ft. 6 in., and fuel consumption for all purposes 56·5 tons.

As in the case of the directly-coupled Diesel engine, Mr. Pounder gave several alternatives for the employment of geared drives. For 7,500 s.h.p., either two seven-cylinder single-acting two-cycle engines, or four similar but smaller engines delivering a total of 8,000 s.h.p. through magnetic couplings, were suggested. In the former scheme, the overall weight was given as 922 tons and the length of engine room as 63 ft.; and for the latter, the weight was 898 tons and the engine room was 74 ft. long. The arrangements proposed for developing 13,000 s.h.p. on two shafts duplicated those described above; the overall weight was quoted as 1,486 tons and the length of engine room as 73 ft. with two engines per shaft, while for four engines per shaft the weight dropped to 1,446 tons and the length of engine room was reduced to 70 ft. The weights quoted referred to trunk-piston engines; the crosshead-type of engine would be slightly heavier. According to Mr. Pounder, the fuel consumptions for the engines mentioned were no higher than for directly-coupled Diesels, the consumptions for the geared engines being 35 tons per day for 7,500 s.h.p. and 60 tons for 13,000 s.h.p.

The above brief summary gives only a bare outline of a series of papers which, individually and collectively, attained a level that should establish them as sources of reference for some time to come, until technical advances or economic changes necessitate revision. In addition to setting forth reasoned arguments for and against the various proposals, they contained much valuable information of a more general nature. Little notice was taken, however, of the first cost of the different types of engine. This is not surprising, perhaps, in view of present conditions, but it is to be regretted that no comparison was attempted, even on a percentage basis. In some cases, first cost and probable expense of overhauling, rather than weight or space or even fuel consumption, might well be the deciding factors.

ELECTRICITY SUPPLY IN NEW ZEALAND.

The generation of electricity by water power is a Government monopoly in New Zealand, and is in the hands of the State Hydro-Electric Department. The first undertakings were established by local authorities and companies, to which the Government granted rights to develop certain areas, but in 1910, the Lake Coleridge scheme in the South Island was put in hand as a direct Government project. Since then, other installations have been built or purchased, and transmission lines constructed, and at the present time 90 per cent. or more of the electrical output of the country is obtained from State-owned stations. The general policy of the Hydro-Electric Department is to supply bulk power, retail distribution being in the hands of local authorities or electric Power Boards, of which there are about 30. In some of the smaller towns, local-authority systems are supplied indirectly from Government sources through Power Boards, but larger towns take supplies directly from the State Department. Many towns and Power Boards have steam or Diesel-engine stations, usually of comparatively small capacity, which, in general, act as standby plants

Some account of the operations of the State Hydro-Electric Department during last year are contained in the latest annual report, which covers the year ended March 31, 1947. The period dealt with was one of some difficulty as the demand for electricity continued to grow, but serious delay continued to occur in the delivery of new plant and spares, and, in addition, two abnormally dry summers were experienced, leading to water shortage. In a statement prefacing the annual report, the Hon. R. Semple, the Minister in Charge of the State HydroElectric Department, refers to the fact that the Government has been criticised because it has not "rushed in and purchased steam generating plant for standby in a hydro-electric system to obviate the present shortage."

This matter of the place of thermal stations in the power economy of New Zealand was also referred to by Mr. F. T. M. Kissel, the General Manager of the Department, in the annual report. Although if the average rainfall had been experienced over the period concerned, the rationing of supply which was imposed would not have been necessary, yet none the less the stage has been reached at which the load demand has overtaken the dry-season capacity of the hydro-electric stations. This is because the war has delayed extensions in hand and projected. The immediate outlook is disturbing, as it is nearly impossible to forecast the time required for any particular work. It seems necessary to continue to exercise a measure of control over the rate of growth of the load, and to speed up the construction of hydro-electric stations. Mr. Kissel stated that it was far beyond the ability of fuel stations to overtake the shortage, and the information available indicated that a steam station could not be built in less than four and a half years. The magnitude of the shortage precluded the consideration of Diesel plants.

In connection with this matter generally, Mr. Semple stated that coal was in short supply and that it was not possible to obtain further large quantities for the generation of electricity. Oil fuel had to be imported and was very high in price; to employ it to the extent necessary to make up the power shortage would be "a very expensive procedure indeed." He stated that the capital costs of water and fuel stations were about the same, but that power generated by the latter had to carry heavy coal or oil costs. He added, in connection with the general question, that the possibility of using natural steam for power generation should not be overlooked.

Mr. Kissel's conclusions on the whole matter are that "the electrical needs of New Zealand can best be met by the concentration of effort upon the major hydro-electric schemes. Any other method of dealing with the problem could only result in delays to the main projects and consequent further deterioration of the power position." As an indication of the delays which have been, and are being, experienced, it may be said that the 21,600-kW unit at the Arapuni station of the North Island system, which was put into service towards the end of 1946, had been ordered in 1939. Its completion allowed the long-deferred overhaul of the older 30,000-h.p. and 25,000-h.p. units to be put in hand. The Arapuni station was originally worked in conjunction with the Horahora station, which was equipped with six 1,310-kVA and two 2,500-kVA units, but this latter station has now been dismantled and submerged by the formation of Karapiro Lake, which serves the new Karapiro station. The first of the three 30,000-kW units with which this station will be equipped went into operation in April, 1947, and did not contribute to the supply during the year with which the annual report is concerned. The second machine was delayed owing to the non-arrival of the final parts for the turbine, but it was hoped that it would go into operation before the end of the year. The third machine is delayed by the production position in Great Britain. Similar delay has occurred in the delivery of turbine parts, ordered in March, 1943, for the 32,000-kW Kaitawa station on Lake Waikaremoana.

Conditions of the South Island system are generally similar, but were not quite so difficult as in the North Island, and rationing was not necessary, but the indications are that it may have to be put into operation. The combined system maximum demand, which includes the Dunedin City Corporation plants and other auxiliaries, showed an increase of 7·8 per cent. as compared with the previous year. In addition to the main system, there is an independent Nelson-Marlborough Section, situated at the northern end of South Island. The main supply comes from Cobb power station, the peak load on which was 16 per cent. higher than earlier records, and the output for the year was 9·1 per cent. greater than for the year ended March 31, 1946. Owing, however, to an extremely dry period, and the increase in demand, the units generated by auxiliary and standby stations increased by 460 per cent. This auxiliary plant includes the Stoke Diesel station, and, as has been the case almost throughout the country, difficulty has been experienced owing to the non-delivery of overdue spares.

In common with a number of other countries, New Zealand has set up a special authority to supervise and foster the supply of electricity to rural areas in which the average distance apart of farms and dwellings is too great to enable a service to be furnished on ordinary commercial terms. The new body, known as the Rural Electrical Reticulation Council, went into operation in the early part of 1946. Under the Act by which it was constituted, all electric supply authorities are required to contribute to a central fund each year a levy of 5*s.* per cent. on sales of electrical energy, and from this fund the Council may make grants to make up any deficiency between revenue and annual costs on approved rural line extensions. On the inception of the scheme it was known in a general way that about 3 per cent. of the population of New Zealand was outside the reach of power lines, but the exact number and the distribution were unknown. Line construction costs differ considerably between various supply authorities, but in order to compute subsidies on a common basis, the Council has standardised the cost of power lines as 350*l.* per mile single-phase and 450*l.* per mile three-phase. This standardised cost is purely for computing purposes, and it is open to supply authorities to apply for increased grants to meet the higher costs of special cases. Applications for subsidies were invited in September, 1946, and, by December, 132 had been received from 27 supply authorities. At the time of the report, 90 of these had been approved for subsidies. These cover 603 miles of line which will be connected to 992 new consumers. The density of consumers in the areas to be reticulated is three per two miles of line. These 132 schemes should be started within the current year, as when inviting applications the Council required that they should be limited to projects which would be put in hand within that period. No useful purpose would be served by allocating funds for other schemes which would not be started within a reasonably limited time.

NOTES.

British Railways.

The British Transport Commission having now considered the measures required to implement the provisions of the Transport Act in respect of the railways, their decisions on broad matters of policy were announced by the chairman, Sir Cyril Hurcomb, G.C.B., K.B.E., at a Press conference held at the Commission's headquarters at 55, Broadway, London, S.W.1, on November 26. On the following day, the railway employees received a brief "memorandum for information and guidance as to procedure." When the main-line railways and most joint lines and small railways are nationalised on January 1, 1948, their familiar names will be discarded, and the whole system, to be known as "British Railways," will be divided into six regions. The London Midland Region will comprise that part of the London Midland and Scottish Railway which lies in England and Wales; the Western Region will correspond roughly to the area covered by the Great Western Railway; the Southern Region, to the Southern Railway; the Eastern Region, that of the London and North Eastern Railway south of a line through Doncaster, Leeds and Manchester; the North-Eastern Region, to the present north-eastern area of the L.N.E.R.; and the Scottish Region will combine those parts of the L.M.S. and L.N.E.R. which lie in Scotland. These regions are provisional, and others may be established later. The Commission will be concerned mainly with questions of policy, and will delegate extensive powers and duties, relating to management and operation, to the Railway Executive. The Commission will act as a body, but the Executive, under the chairmanship of Sir Eustace Missenden, will be organised on functional lines. The functional organisation will also appear at the regional headquarters, where a Chief Regional Officer will co-ordinate the work of his officers. So far, the Commission have only dealt with broad issues, and it is clear that they wish to avoid the dangers of over-centralisation. The travelling public, commercial customers of the railways, and the employees, will not see any significant change for a considerable time.

The Thomas Hawksley Lecture.

One more field of the scientific and engineering developments of the war was revealed when Sir Alwyn Crow, C.B.E., M.A., Sc.D., delivered the 34th Thomas Hawksley Lecture, on "The Rocket as a Weapon of War in the British Forces," before the Institution of Mechanical Engineers on Friday, November 21. Although, for obvious reasons, Sir Alwyn could not describe the more recent developments, he was able to give a comprehensive review of the pre-war work and the production of a variety of rocket types during the war, as he directed the investigations which were initiated in 1935. The original main lines for investigation were, in order of priority, for anti-aircraft defence; for long-range attack; as a weapon against hostile aircraft; and to assist the take-off of heavy aircraft. However, owing to the demands of other projects, it was only possible to concentrate on the development of a defensive weapon, during the years preceding the outbreak of war. The first experimental anti-aircraft rocket was of 2-in. calibre with a solid propellant of the cordite type, the performance of which was to be equivalent to that of the 3-in. anti-aircraft gun. The 2-in. rocket was tested in 1937, and a 3-in. rocket was developed and tested in 1938. A regiment was formed in 1940 to undertake the operational employment of 3-in. rockets, and it scored its first success on April 7, 1941. Multi-barrel mobile mountings were used in North Africa and the United Kingdom. A 5-in. rocket motor was developed which, although not used operationally, had a profound effect on subsequent design. Sir Alwyn then described typical war-time developments of rockets for anti-aircraft attack, as barrage weapons for area "softening," and mass bombardment, as rockets carried on aircraft for land and sea targets, and for assisted take-offs of aircraft. As barrage weapons, rockets were fired in salvoes, and afforded considerable support in combined-operation landings. Sir Alwyn confined himself to a review of rockets with solid fuel, because liquid-fuel rockets were not used by the British Forces.

The Rotterdam Lloyd Liner "Willem Ruys."

The departure from Rotterdam, on December 2, of the new twin-screw Rotterdam Lloyd motorship Willem Ruys is an event of somewhat exceptional importance, apart from the interest that attaches to the maiden voyage of any large liner. She may be regarded, indeed, as a symbol of the post-war renaissance of Dutch shipbuilding, and the restoration of the Netherlands flag to its former position in the specialised field of first-class passenger transport by sea. As we hope to describe the vessel in detail in an early issue of Engineering, it will suffice to mention here that she was laid down in January, 1939, at the De Schelde shipyard at Flushing, but was not launched until July, 1946. Her length between perpendiculars is 609 ft. 10 in., beam 82 ft., and draught 29 ft. 2 in.; and her gross tonnage is 21,300. The propelling machinery consists of eight Sulzer two-cycle single-acting engines arranged in sets of four, each set driving one propeller through electro-magnetic couplings and mechanical gearing. The designed service speed is 21 knots, but on the measured-mile trials on November 17, which we were privileged to attend, the ship attained a maximum speed of 24·6 knots.

LETTERS TO THE EDITOR.

DISASTER OR RECOVERY?

To the Editor of Engineering.

Sir,—The British mining industry during the past 25 years has produced largely in excess of 250,000,000 tons per annum; indeed, its capacity in 1938-39 considerably exceeded 250,000,000 tons per annum under full-time working conditions, and though in 1938 it suffered from acute unemployment (15·5 per cent.) and want of trade (35 days lost), even then the tonnage of coal raised was 230,000,000. In 1937, output was 240,000,000 tons, with want of trade (17 days lost) and 15 per cent. unemployment. To-day, the pits of this country are equipped as never before for high output, over 20,000,000*l.* having been expended on mechanisation during the war period. The paltry output of 177,000,000 tons of coal in 1946 actually represents only a comparable pre-war output of 150,000,000 tons, as the percentage of dirt and incombustible material in coal raised exceeds pre-war figures by 27,000,000 tons.

Why has there been this catastrophic decline in coal output of 80,000,000 tons with a decrease in man-power of only 9 per cent.? It will be seen that the actual annual loss of coal output, comparing 1938 with 1946, considerably exceeds 80,000,000 tons per annum if due regard be had to unemployment and want of trade in the industry in the years 1937 and 1938, and the fact that productivity to-day should be in the order of 25 cwt. per man-shift instead of 20 cwt. (it was 23 cwt. prior to the war).

In my opinion, this decline in coal output is due largely to indolence and restriction of output by the miner, who time after time has dishonoured pledges given to increase output. The Government's conspiracy of silence with regard to the facts of the serious situation in the coalfields constitutes a deplorable neglect of the national interest. It must be clearly realised that the only sure antidote to inflation is the increased production of goods; but increase in production, which could reduce the burden of taxation, is crippled by shortage in coal output. Restoration of coal output would provide 200,000,000*l.* to 300,000,000*l.* per annum from sales of export coal, rendering food cuts and the purchase of American and Polish coal unnecessary. Disaster can only be averted by the restoration of discipline in the coalfields and with it, increased output and a decrease in the present fantastic prices for coal—a situation fully deserving caustic American comments.

European economic stability is dependent upon German industrial health and well-being, for Germany forms the economic linch-pin of the Continent. The acute shortage in output from the Ruhr industries, coupled with the lack of British coal exports, are producing conditions that will be beyond American power to rectify. Social disorder and appalling distress could be prevented by the restoration of the pre-war volume of coal exports from Britain; such, I believe, are the grave responsibilities of the British Government in European economy.

Yours faithfully,
R. Cecil Smart.

146, High-street,
Harborne, Birmingham, 17.
November 20, 1947.

SPACE HEATING IN GREAT BRITAIN.

To the Editor of Engineering.

Sir,—In your issue of November 7, you published, on page 446, an article on Dr. A. Parker's Institute of Fuel paper giving comparative "coal-economy and efficiency" figures of 30 to 40 per cent. for gas fires and 15 to 18 per cent. for electric heating, the "working efficiency" of electric space heaters being taken as 80 per cent., in contrast with the usual value of 100 per cent.

I have devoted an entire I.E.E. paper, referred to in your issue of April 4, 1947, page 266, to an attempt to show that the form of comparison still adhered to by Dr. Parker is fallacious, and have proved that if a correct procedure is adopted, "no decided difference in regard to coal economy exists between gas and electricity for domestic heating purposes." It is, of course, impossible here to repeat my argument against the percentage efficiencies used and, particularly, against the spreading of the losses of the gasworks process over both gas and coke in proportion, resulting in gas being debited with, approximately, only one third. I would ask Dr. Parker, however, why, in adopting this method, he does not mention that the "coal-economy efficiency" of coke is much inferior to that of coal, if either is used in comparable conditions. Taking the relevant figures in the Egerton and Simon Reports, something like 25 per cent. more coal is consumed if coke is used instead of coal; but nothing is said against such an apparent wastage of the national coal resources.

It seems to be high time that an end be put to the practice of allocating carbonisation losses to gas and coke on the "swings and roundabouts" principle, making gas superior to electricity and coke inferior to coal. Having regard to the highly important economic issues involved, a definite clarification appears more than overdue. In the meantime, I suggest that no significance should be attached to percentage "coal-economy efficiencies" stated in connection with products of the carbonisation process.

Yours faithfully,
P. Schiller.

25, Pembridge-gardens,
London, W.2.
November 20, 1947.

THE SURVEY OF SCIENTIFIC MAN-POWER.

To the Editor of Engineering.

Sir,—I have read with interest the article on "The Survey of Scientific Man-Power," which appeared in your issue of November 7, 1947, on page 445, *ante*, and would ask your indulgence if I comment on one or two points in respect of which the writer may, quite unintentionally, have given your readers a wrong impression.

In the first place, the article contrasts the number of copies of the questionnaire stated to have been printed, which is given as 200,000, with the number of names on the Register in 1945, which is stated to be 45,000. This, it says, "suggests either a great deal of wastage or possible repetitions of the inquiry at relatively short intervals." I should like to point out that, as stated by Mr. Isaacs in the House of Commons on November 11, the number of copies printed was approximately 160,000; on the other hand, the 45,000 names mentioned in the Barlow Report are those of scientists only, and do not include some 120,000 engineers who

are on the Register. The conclusion as to wastage or repetitions of the inquiry is therefore based on false premises.

The second observation in the article on which I would comment is that the survey suffers from "a common departmental tendency to frame an arbitrary series of pigeon holes." This statement is followed by certain examples designed to show that the survey can only produce information within a very limited field, and attention is drawn to certain omissions. Had every specialised branch of science or engineering been specified in Section 12, the form would have become unwieldy, and Item 61 of that section gives scope for addition. Reference is not made in your article to the fact that a section had been purposely designed to deal with specialisation, which gives each individual ample opportunity to record his specialised experience.

I would add here that it would be quite incorrect to assume that the form was drawn up without consultation with highly-qualified scientists and engineers. Moreover, before the survey was commenced, experimental forms were issued to a cross-section of individuals in the various branches of science and engineering in order that the reactions of typical recipients might be obtained. As a result, alterations were made before the form was printed.

Finally, the article casts some doubt on the value of the assurance given by Sir Godfrey Ince in his covering letter that information collected by the survey "will in no circumstances be used as a basis for any form of administrative control or direction." This scepticism was based on the statement that the Control of Engagement Order, which does not apply to holders of professional qualifications, "had been in force only a matter of weeks when hints were being dropped, seemingly based on informed expectation, that this reservation might have to be abandoned." On this point, I can only suggest that the writer of the article has attributed to newspaper statements an authority which they did not possess. I can assure you that I know of no justification whatever for any such "hints," and am fully authorised to state that there is no such intention so far as this Ministry is concerned.

Yours faithfully,
L. H. Hornsby.
Director of Public Relations.
Ministry of Labour and National Service,
St. James's-square, London, S.W.1.
November 21, 1947.

[Evidently we were wrong in assuming that, because 200,000 copies of the form were ordered, that number was printed; but as the Minister's disclosure, that only 160,000 were printed, came four days after our article was published, our assumption was, perhaps, reasonable. For the rest, we would merely add that evidence accumulates that the doubts and difficulties we indicated seem to be felt fairly widely among engineers who are engaged in industry (the qualification is important); and would reaffirm our view that the form, as circulated, is not well designed to achieve its declared purpose.—Ed., E.]

To the Editor of Engineering.

Sir,—Towards the end of your article on the above subject in the issue of November 7, you refer to the large number of forms which have been printed, these being more than four times the number of names on the Register. I am a member of both the Mechanicals and Electricals, and I received two forms. The method of addressing leads me to believe that the machinery of the Institutions was used in distributing forms, and that, therefore, all engineers who were members of more than one Institution received more than one form. This may be at least a partial explanation for the number of forms printed.

The duplication in the issue of forms leads one to wonder how far the results of the analysis will be accurate. If it is intended to correlate the forms as received from those engineers who complete them, it is difficult to see why this correlation should not have been done before the forms were issued.

Yours faithfully,
C. H. Smith.
98, West George-street, Glasgow, C.2.
November 21, 1947.

THE IRON AND STEEL INSTITUTE.

(*Continued from page* 499.)

Continuing our report of the recent annual autumn meeting of the Iron and Steel Institute in London, we now deal with the second session, held on the afternoon of Wednesday, November 12.

Producer Gas.

The first three papers on the agenda were discussed jointly. They were concerned with producer gas, and in the first, "A Note on Variations in Producer-Gas Quality," the author, Mr. J. E. de Graaf, of the Royal Dutch Iron and Steelworks, Ijmuiden, Holland, gave an account of some factors, including the tar content and humidity, which influenced the quality of producer gas. He stated that the quality of the gas was improved by high volatile-matter content, high-fusion point of the ash, and other factors, but especially by avoiding "fines" in the coal. The influence of channelling on gas analysis and humidity was considerable. To quote an actual case, the gas from a serious channel had a moisture of 81 grains per cubic foot, as compared with 30 grains for gas from a good fuel bed. Similarly, the carbon-dioxide content was 15·7 per cent., as compared with 5·5 per cent. for good gas; the carbon-monoxide content, 7·3 per cent. against 26 per cent.; and the hydrogen content 4·3 per cent. against 15·0 per cent.

The second paper was entitled "The Distribution of Fuel in Gas Producers" and was by Mr. M. L. Hughes, of the British Iron and Steel Research Association, Swansea Laboratories. The author stated that a "slice"-model technique had been employed to examine the distribution of the fuel in gas producers, using various charging methods under different conditions. The technique was based upon the use of small models, as employed by Dr. H. L. Saunders at the Imperial College of Science and Technology. The model represented a diametral "slice" across the centre of a gas producer. The model was fitted with a sliding glass front, through which the fuel-bed contour could be observed and photographed, and was enclosed by metal shutters at the back. The model was designed to use any one of six charging bells and the body or diametral width could be made to be either 9 ft. or 7 ft. 6 in. A piston in the base of the model could be moved upwards or downwards to represent varying heights of ash-bed surface. A second and larger "slice" model and circular models were also employed. As a result of the experiments made, it was concluded that the hopper-and-bell system, as employed usually on static hand-charged producers, yielded unsatisfactory results. Unless the bell were exceptionally large in proportion to the body, there was a shortage of material at the wall, accompanied by an undue proportion of the coarse material of the charge. This was highly undesirable. The centre received fuel mainly by rolling, which, obviously, was a source of size segregation. Increasing the bell diameter, to increase the supply to the perimeter, accentuated the difficulty at the centre.

A distributing bell, as used in automatic charging systems, deflected the material outwards to a much greater extent. A relatively small bell was capable of throwing an excess of material to the perimeter, whence a proportion of the coarse constituents rolled back towards the centre, leaving an excess of "fines" at the wall. Much improved results could be obtained in static producers by the use of an auxiliary device for deflecting a portion of the charge inwards. By the same method, it could be arranged for coarse material to be deflected inwards. Works tests had confirmed the results obtained from model experiments.

In the third paper on "Experiments on Gas Flow in Producer Fuel Beds," also by Mr. M. L. Hughes, reference was again made to the "slice" model of a static producer. The author stated that the model had been utilised to demonstrate the flow of gas through fuel beds produced in various ways. The path of the gas was found to depend mainly on size segregation and the relative porosity of the ash and fuel beds. Gas velocity could be varied considerably with little effect on the hemispherical wave front produced by the flow of the gas. A comparatively small change in bell size in static producers could cause a marked change in the gas flow without altering the form of the fuel-bed contour. The relative permeability of ash bed and fuel bed had a marked effect. A porous ash bed increased lateral spread of the wave front, but a porous fuel bed on a less porous ash bed induced a preference for central travel. The existence of hot and cold zones in the fire might lead to coarse and fine zones in the ash bed, and this could modify gas flow appreciably. The improved distribution of the fuel produced by internal deflectors had been found to be accompanied by more uniform gas flow.

Mr. M. W. Thring, who opened the discussion, said that the three papers fitted together well, because Mr. De Graaf provided a large-scale verification of the ideas which Mr. Hughes had put forward and Mr. Hughes provided a method of solving the problem posed by Mr. de Graaf. All the work done by the British Coal Utilisation Research Association confirmed what Mr. Hughes had said concerning segregation affecting the flow pattern enormously. Obviously, segregation was the crux of the whole problem, and, in future work on gas producers, it would be necessary to decide whether really intensive work should be done to avoid segregation or whether sized fuel was essential. On the question of clinker adhesion, he wondered whether the use of carbon linings in the lowest region of the gas producer had been considered. In view of the work done on blast furnaces in that connection, it was an interesting point. Another problem for future research was to find a really satisfactory method of handling the ash in a gas producer, because it was ash difficulties which prevented the adoption of pre-heat, oxygen enrichment and other desirable developments. Mr. A. T. Grisenthwaite, who spoke next, said that it seemed to him that the contour of the fuel bed, or the inequalities in the fuel bed, might be masked or marred by the particular rake or blast-distribution or ash-removal method employed. Similarly, different gradings of fuel and different types of fuel affected the desirable contour.

Dr. R. Wild described experiments carried out at the Imperial College of Science using a model which was a $\frac{1}{4}$-th scale replica of a static producer. The results obtained suggested very definitely marked channelling when charging by means of a normal bell and hopper was adopted, while in the case of compensated charging, using a device for deflecting the material across the producer in such a manner that a uniform bed was obtained, there was no channelling. Using coal with a very wide, irregular grading, greatly improved producer operation could be obtained on their small-scale model by employing compensated charging. The next speaker, Mr. G. W. C. Allan, stated that the most important conclusion pointed out by Mr. Hughes was the effect of the segregation due to an initial difference in level in the top of the fuel. This, he believed, was the cause of all the trouble in the subsequent operation of gas producers. The influence on the segregation of levelling bars and rakes should be studied, because, quite clearly, if a rake were operated in a purely superficial manner, it would not achieve the effect intended. Moreover, as the fuel of the future seemed likely to a 1-in. slack, work on segregation was probably very important. The hood and the shape of the producer shell also warranted further study, as had been indicated as the result of full-scale work done in the British Coal Utilisation Research Association's laboratories, and also by the work of Mr. Hughes.

Dr. A. H. Leckie stated that Mr. de Graaf had indicated a very good reason for the variation in the heating power of a flame. His results showed that the tar content of gas varied statistically in a random manner from just below 4 to just over 7 grains per cubic foot, and this, he believed, indicated that the calorific value of hot crude gas would vary by about 10 B.Th.U. per cubic foot, in a very random manner. He also agreed with Mr. de Graaf concerning the disadvantage of introducing the air into the producer by means of a steam blast and the lack of control which that gave. He was glad to note that in Mr. de Graaf's works the steam and

the air controls were independent, and it was to be hoped that this would encourage British works to make them independent.

Mr. R. Whitfield said that, when manufacturing the numerous emergency gas producers required during the war, it had been decided that, in view of the fuel which would have to be dealt with, the two most important features were the design for the entrance of the blast into the producer and the method of charging. The conclusion had been arrived at that there must be a carefully graduated entrance of air and steam into the base of the producer. Numerous types of charging bells had been tried, including square, round and miscellaneous shapes, and finally a charging pyramid had been adopted in place of the charging cone. In a few comments on Mr. de Graaf's paper, Mr. M. L. Hughes, who spoke next, stated that this author's definition of "fines" was material under $\frac{3}{4}$ in. in diameter, and he had spoken of 10 per cent. of this. There was a considerable degree of scientific control, and it was surprising that the composition of the gas was not better. In South Wales, "fines" would be described as material under $\frac{1}{4}$ in. diameter, not $\frac{3}{4}$ in., and it was customary to have from 30 to 40 per cent. of this. Even under such conditions, however, the gas made, he believed, would be more constant than that described in the paper.

In a brief reply to the discussion on his paper, Mr. J. E. de Graaf said that the fluctuation of the luminosity of the open-hearth flame had not been measured solely by eye; instruments had also been used. In general, it was perhaps true that tar was evolved more quickly from fine than from coarse particles and in this connection it would appear that the smaller sizes of coal were advantageous. Mr. M. L. Hughes, who also replied to the discussion on his two papers, said that the potential function of the gas producer was that it could be adapted to use poor materials, leaving the better-quality coals for more important purposes. The use of carbon linings to overcome clinker adhesion had been suggested, but this trouble was got over in many producers by the use of water-cooled walls. He was in entire agreement with the statement that the fundamentals for the successful operation of gas producers were correct distribution of the fuel and of the blast and the removal of the ash. Any trouble in the ash bed, due to irregular ashing, was reflected in producer performance. Mechanical ashing was not what it ought to be; the uniform removal of the ash at every point of the producer fire bed was not always achieved with some of the mechanical devices now employed. The idea of a triangular pyramid in the charging equipment was interesting. He could not visualise how it would work, but he had noted the point with interest.

Roof Pyrometer for Open-Hearth Furnaces.

The last paper on the agenda for this session contained a description of "A Photo-Electric Roof Pyrometer for Open-Hearth Furnaces," and was by Mr. T. Land, of the Research Department, Messrs. William Jessop and Sons, Limited, Sheffield. It stated that a photo-electric pyrometer, employing a selenium barrier-layer photo-electric cell had been developed for the measurement of the roof temperatures in a 50-ton acid open-hearth furnace, operating on producer gas and employed in melting a wide range of carbon and alloy steels. The cell used in the present pyrometer was the size and shape of a halfpenny. It consisted of a disc of iron coated on one side with a photo-sensitive layer of selenium which had a transparent metallic coating on its surface. Such cells were cheap and robust and were easily incorporated in an instrument. The optical system comprised a lens, a photo-electric cell, and two stops, each having a 7-mm. diameter aperture, placed between the lens and the cell, and separated by a distance of 15 cm. A water-cooled enclosure surrounded the photo-electric cell and a heat-resisting steel tube, 2 in. in diameter, projected in front of this enclosure up to the furnace wall. Compressed air was introduced into this tube and provided an optical path free from smoke and fumes. The rapidly moving air also prevented the entry of hot metallic particles from the furnace, which, otherwise, would fall on the lens and cause errors of measurement. The pyrometer was mounted on a stout girder attached to the buckstays of the furnace, immediately above the tap-hole. The photo-electric cell was connected to a micro-ammeter of 500-ohms internal resistance, giving a full-scale deflection for a current of 15 micro-amperes. The meter had been calibrated in the laboratory before installation, by sighting on a standard tungsten-ribbon filament lamp. The pyrometer had given excellent service for a period of six months, with very little maintenance, and no measurable change of calibration had occurred during this period.

The discussion was opened by Mr. J. A. Hall, who stated that investigation had shown that a quite remarkable improvement had been made in the barrier-layer photo-electric cell during the past four years, and he believed that there was little cause for concern on the score of drift or fatigue of the cells. Recent observations made in Sheffield appeared to bear out the idea that there was a larger variation in apparent brightness from place to place in the roof of an oil-fired furnace than in that of a gas-fired furnace. During charging, there was a 30 deg. C. variation in the gas-fired furnace and a 60 deg. C. variation in the oil-fired furnace, while, during refining, the variation was only 10 deg. C., in the case of the gas-fired furnace, and 50 deg. C. when using oil as the fuel. This rather suggested that while a pyrometer such as the author's could give a good steady reading, and one which would be quite satisfactory for operating the furnace, it was still by no means certain what relation the readings of that pyrometer would bear to the true temperature of the roof.

Mr. F. L. Robertson said that very few men, apart from steel melters, realised what an emotionally disturbing matter it was to melt an open-hearth furnace roof. Now that a melting-shop manager had some measure of roof temperature, he could afford to experiment with such matters as port sizes, fuels and other matters without raising the opposition of the melting staff. The firm with which he was connected had been pioneers, in this country, of the radiation tube pyrometer for roof-temperature work. It would be nine years next January since they had started to run all the furnaces in one shop to strict roof-temperature rules, and shortly afterwards the other two melting shops had followed suit. They had considered the radiation tube pyrometer to be a great boon and many of their melters would have to learn their work all over again if they did not use roof-temperature measurement. The greatest, and, in fact, the only, difficulty in getting the radiation tubes (which had not been made for roof-temperature work) to operate was to invent a suitable housing to hold the tubes. Like the author, they used compressed air to keep a pressure in front of the instrument to prevent dirt and dust from the furnace from entering. He felt that all melting-shop managers were most grateful to the engineers, inventors and scientists like the author and Mr. Hall, who gave them help in the very great responsibility of running many furnaces within 20 deg. C., of the melting point of the roof refractories.

Dr. J. H. Chesters said that in the works of the United Steel Companies, Limited, it was hoped, in the near future, to adopt automatic control on at least one furnace, and probably two. The scheme was based on having a roof pyrometer to be the master controller of the system. This would control the oil flow, which, in turn, would control the air flow, and, since the oil would be linked also to the atomising steam, the roof-temperature instrument would control everything. It was therefore extremely important to have an instrument which was not only very accurate but, above all, reliable. The next speaker, Mr. D. A. Oliver, stated that a definition of industrial research had sometimes been asked for. Industrial research meant the pursuit of the solution to a problem with as few fetters as possible, leaving all talk of applications and financial returns until afterwards. The present work had started academically, but the first run of the instrument on a furnace, had paid for its complete development.

Mr. M. W. Thring stated that the roof of an open-hearth furnace was not very suitable for calibrating pyrometers, although there was a tendency to regard it as an ideal target for this purpose. He hoped that it would be possible to introduce an instrument on the melting stage which would be more suitable for calibrating pyrometers and checking them conveniently. The next speaker, Mr. D. Manterfield, said that one of the author's instruments had been installed on a furnace and sighted on the usual target area, just over the tap-hole. A total-radiation instrument had been sighted on the same target area from a similar position on the other side of the furnace. When the author's instrument had been first installed it was fitted with an indicating micro-ammeter, while the total-radiation pyrometer had the usual recorder. A number of checks had been taken regularly over a series of charges using an optical pyrometer and during this period the standard difference between the author's instrument and the optical pyrometer was of the order of 10 deg. C. As a matter of interest, it might be mentioned that the radiation unit had a standard deviation from the mean difference of 17 deg. C. These deviations included the errors of the optical pyrometer as well; hence, in the circumstances these results were regarded as very good. One thing, however, was lacking. For a melting shop an indicator was not satisfactory; a recorder was wanted. This was eventually installed, but owing to the extreme sensitivity of the author's instruments, a band of readings rather than a line was given. Finally, a large condenser was fitted across the instrument, which effectively damped out the excessive sensitivity while retaining sufficient to record any real deviations in roof temperature.

Dr. A. H. Leckie asked if the author could arrange for his pyrometer to scan the roof like a television camera, and so record the temperature of more than one place on the roof more or less simultaneously, and give a band on the recorder? In that manner, the melting-shop manager would have a much better guide regarding the true condition of safety of the whole of his roof. The field of view might not be very great, but it might be an improvement on the practice of sighting on one point alone. Mr. F. Steyhart, the next speaker, commenting on this matter, said that, generally speaking, it might be easier, from a purely technical point of view, to use a number of instruments and switch over from one instrument to another.

Mr. T. Land, replying to the discussion, said that he believed scientists were now passing out of the stage of the development of instruments and into that of examining the conditions of measurement. It was true that a well-designed pyrometer would retain its calibration for years to within 5 to 10 deg. C. There should be no difficulty in doing this, but it did not mean that there should be no inspection. Some of the things which could cause errors were splashes of metal on the lens, the obstruction of the sighting hole, and so forth. He advocated the use of two pyrometers placed side by side, sighting from separate holes on the back wall. The pyrometers could work with the same recorder, or two different recorders, or with a large indicator into which one or the other were switched at regular intervals. This arrangement had the great advantage that it showed up at once any obstruction to either of the pyrometers or any failure of one of the instruments. It was under Mr. Oliver's direction, and largely due to his inspiration, that the development under discussion had occurred at all, and he agreed with him that, in research work, the programmes and problems should not be laid down too rigidly. A considerable latitude should be left to the enterprise and interest of the individual, because, quite often, they led to important practical developments. An important feature of future work was that, although Mr. Thring had not said so, he knew that he was preparing a standard light source on which radiation pyrometers of different types could be calibrated and by which their characteristics could be examined. Mr. Leckie's suggestion of scanning the roof would probably raise mechanical difficulties, particularly in the hot zone of open-hearth furnaces; a number of pyrometers connected to a switching arrangement would no doubt prove more satisfactory.

(To be continued.)

EXHIBITS AT THE BUILDING EXHIBITION, OLYMPIA.

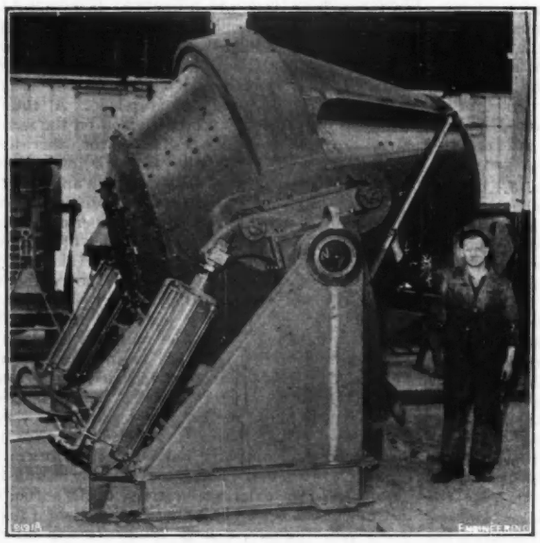


FIG. 1. 3-CUB. YD. CONCRETE MIXER; MESSRS. WINGET, LIMITED.

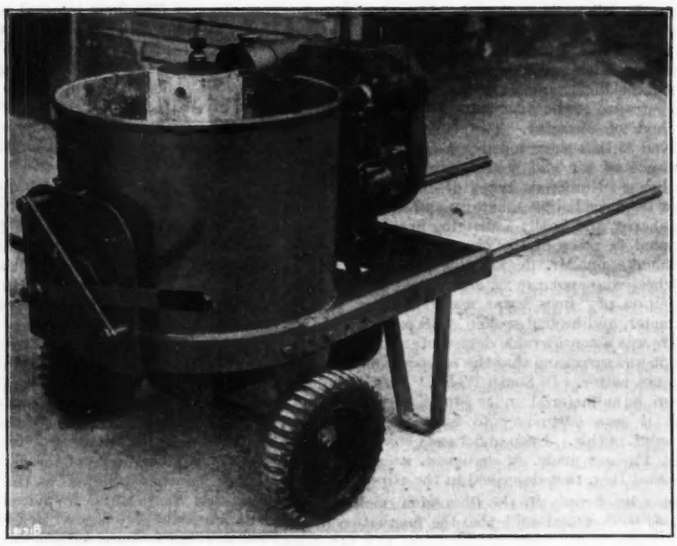


FIG. 2. "WHIRLPOOL" MIXING MACHINE; MESSRS. WINGET, LIMITED.

THE BUILDING EXHIBITION AT OLYMPIA.

As briefly recorded on page 496, *ante*, the 22nd Building Exhibition opened on Wednesday, November 19, and will close on Thursday, December 4. The Grand and National Halls at Olympia are fully occupied, and although building and building materials are rigidly controlled by the Government, many suppliers and manufacturers have arranged interesting exhibits. In particular, there are numerous examples of machines and devices to relieve the shortage of labour in the building industry, and there are new materials which, although introduced as substitutes for those employed traditionally, often possess improved properties, such as better heat and sound insulation. The stands of Government departments are designed to educate architects, builders, and the public, in the efficient use of fuel, mechanisation in the building and allied trades, the practical application of the results of scientific research, and other desirable objects.

The principal machine on the stand of Messrs. Winget, Limited, Rochester, Kent, is the 3-cub. yd. Winget-Koehring concentric-zone tilting concrete mixer, a photograph of which is reproduced in Fig. 1, on this page. The drum has a single opening; and a battery of two, three, or four mixers may be arranged for charging by a single chute from the proportioning plant, and for discharging directly into a central hopper. The mixer discharges a batch in 8 to 10 seconds. Power is provided by a 40-h.p., 1,450-r.p.m. squirrel-cage motor having a high starting torque, through an enclosed train of gears. The maximum inside diameter of the drum is 7 ft. 7 in., the opening is 2 ft. 11 in. in diameter, and the drum rotates at 11·5 r.p.m. It is provided with renewable abrasive-resisting steel liners. The shape of the drum and the open-type mixing blades ensure efficient mixing. The frame of the machine is of welded box construction, and the drum is tilted by pneumatic cylinders using compressed air at 100 lb. per square inch. Messrs. Winget, Limited, are also showing a hand-fed tilting mixer and a new machine known as the Winget "Whirlpool" mixer, which is illustrated in Fig. 2, on this page. It is designed for light mixes, and is particularly suitable for light-weight air-entrained concrete or sawdust concrete, plaster, mortar, powders, etc. The circular pan contains two sets of blades rotating close to the wall of the pan about a vertical axis, one set being near the top and the other near the bottom. The blades are inclined, to impart a lifting motion to the material, and the upper trailing edges of the blades are serrated to give a combing effect. The material is moved continuously upwards at the outside and downwards at the centre, and a thorough mix with maximum aeration are achieved. The Winget hand-fed tilting mixer is a new design based on the firm's extensive experience of these machines.

Many other concrete mixers are shown at the Exhibition, some of which have already been described in our columns. Messrs. Goodwin, Barsby and Company, Limited, Leicester, are showing several mixers, including a 5/3½-cub. ft. portable mixer, with an output of 23 to 25 cub. yds. a day. The centre-line of the drum is at right-angles to the axis of the two rubber-tyred wheels—an arrangement which is claimed to ensure stability when the mixer is being towed as well as when it is in use. The machine is supported on the wheels and two splayed feet, and the frame is shaped to facilitate the approach of a wheelbarrow for discharging. The mixer is driven by a Villiers 2-h.p. petrol engine.

The stand of Messrs. Acrow (Engineers), Limited, 33, Catherine-place, London, S.W.1, exhibits adjustable steel propping and shuttering, light-alloy tubular scaffolding, saw benches, storage bins, a bar bender, and a concrete mixer. The bar bender is made in two sizes with alternative electric, petrol-engine, or Diesel-engine drive. The larger model, with either a 7½-h.p. electric motor or a 10-h.p. Diesel engine, will bend a bar 2 in. in diameter, or several bars the combined cross-sectional area of which does not exceed 3 sq. in. The smaller model, with either a 5-h.p. electric motor or a 5-h.p. petrol/paraffin engine, will bend a bar 1½ in. in diameter, or several bars the combined cross-sectional area of which does not exceed 2 sq. in. The bending gear consists of two circular steel tables (one for the maximum capacity of the machine, and one for an intermediate capacity), which rotate separately and in either direction, as required, between three fixed steel bars or back-rest blocks. Each table is drilled with a central hole with a series of holes at different radii round the top; the back-rest blocks are also drilled with a series of holes. Various pins and formers fit in these holes, to suit the diameter of the bar and the radius to which it is to be bent. The machine incorporates several devices for safety purposes and to facilitate repetition work. It is mounted on four wheels; and lubrication, except for the engine, is by means of grease nipples. The Acrow 3½-cub. ft. portable tilting mixer, also shown on this firm's stand, has several interesting features. The drum, mounted on roller bearings, is in the form of two cones which ensure an efficient mixing action; it is only necessary to tilt the drum 40 deg. to discharge. The mixer is charged through a conveniently wide chute; and the two-wheeled axle is mounted on helical springs. Either electric or petrol-engine drive is available.

Messrs. Millars' Machinery Company, Limited, Thorley Works, Bishop's Stortford, Hertfordshire, exhibit a wide range of builders' and contractors' plant, including a mobile weighing and batching plant; a non-tilting-drum 10-cub. ft. concrete mixer; a drop-bottom gauge box (these three plants are designed to conform with British Standard Specification No. 1305 (1946)); a 3-in. open-discharge diaphragm pump and a 3-in. self-priming contractors' centrifugal pump, both of which are driven by petrol engines; and a 4-ft. 6-in. diameter roller pan mixer with a 5-h.p. Diesel engine. The mobile weighing and batching plant has been introduced recently to provide the same output as the firm's well-known stationary plant, with the added advantage of mobility. It is provided with four pneumatic-tyred wheels, and may be towed at a maximum speed of 20 miles an hour. The overall dimensions, when the plant is ready for towing, are 15 ft. in length, 7 ft. 6 in. in width, and 13 ft. 6 in. in height; the weight is 4½ tons. The output depends on the number and size of mixers used in conjunction with the plant, but the maximum is about 200 cub. yds. a day.

The Sinex Engineering Company, Limited, 2, Caxton-street, London, S.W.1, and Messrs. M. Semet and Company, Limited, of the same address, are showing, respectively, vibrating screens and moulds for welding bars in reinforced concrete. The vibrating screens are available in a wide range of types for foundry sand, flour, ground rubber, coal, ballast, powders, etc., and each is actuated by an electric motor with an out-of-balance revolving component causing a high-frequency vibration. Mention may be made of the knock-out grid for foundries, which will remove the sand from a 14-cwt. moulding box in 20 seconds. Sinex electric vibrators are also applied to chutes, hoppers, bunkers, etc., for discharging materials; and to *in situ* and pre-cast concrete. A "Secrom" mould is a device to facilitate the electric welding of the ends of two reinforcement bars, and obviates the necessity for special preparation. It is essentially a heat-resisting mould, forming a hollow under the gap between the ends of the bars, and attached to each bar by a cotter pin. A typical time for welding a joint, using a Secrom mould, is 20 minutes for 2-in. diameter bars, compared with 55 minutes for the conventional method; and, furthermore, additional time and expense are saved by eliminating prepara-

EXHIBITS AT THE BUILDING EXHIBITION, OLYMPIA.

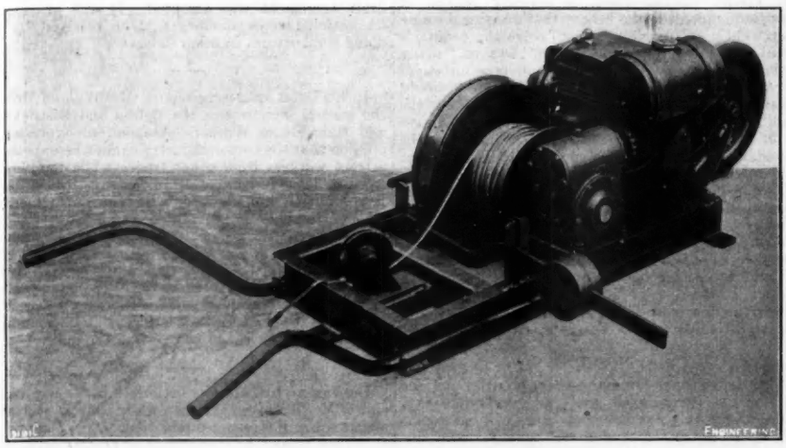


FIG. 3. PORTABLE WINCH; THE WICKHAM ENGINEERING COMPANY, LIMITED.

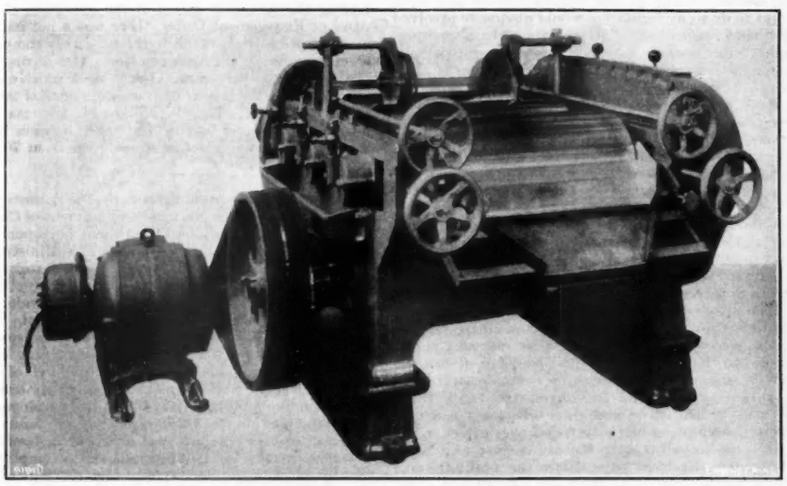


FIG. 4. THREE-ROLL PAINT MILL; MESSRS. G. J. WORSSAM AND SON, LIMITED.

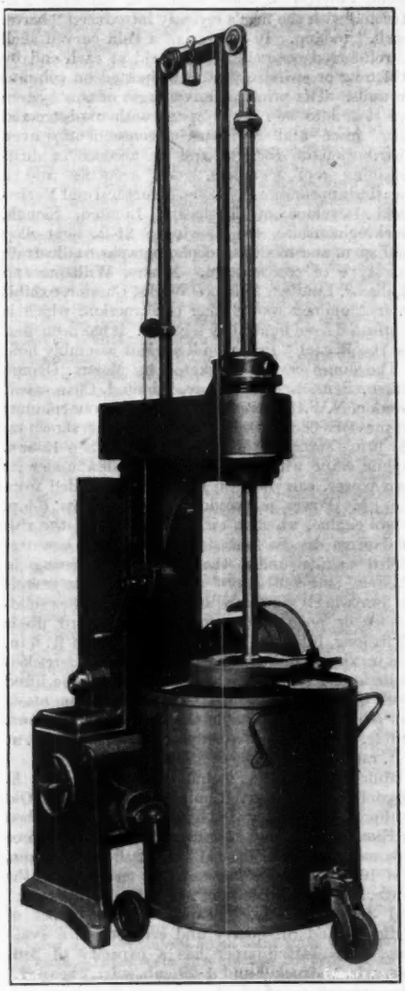


FIG. 5. HIGH-SPEED PAINT MIXER; THE KEENOK COMPANY, LIMITED.

tion of the ends and rotation of the bars; the joint can be made *in situ*.

The Wickham Engineering Company, Limited, 34, Victoria-street, London, S.W.1, are exhibiting two builders' hoists, a winch, a diaphragm pump and a centrifugal pump, several cranes, and a portable winch which is illustrated in Fig. 3, on this page. It will exert a pull of 4 cwt. at 30 ft. a minute, or 2 cwt. at 60 ft. a minute, and weighs approximately 2¼ cwt. As will be seen from the illustration, it is mounted on a wheelbarrow-type frame with a pneumatic-tyred wheel; it is provided with a cover, not shown. A Villiers four-stroke petrol engine drives the winch through a Renold roller chain, an enclosed worm gear, and a clutch. A weighted lever, which applies the brake and disengages the clutch simultaneously, is raised by the operator to work the winch. The machine is anchored by means of drilled brackets on the frame.

Messrs. Kango Electric Hammers, Limited, Morden Factory Estate, Lombard-road, South Wimbledon, London, S.W.19, are exhibiting their range of electric hammers. A new model, type "E," has a considerably higher power-weight ratio than previous models. It weighs 21 lb. 14 oz., will run on direct or alternating current at 200 to 250 volts, and requires 500 watts. The Metal Agencies Company, Limited, Colston-street, Bristol, 1, are showing several appliances for builders and contractors, including a concrete-block machine. It is designed to produce solid, single-cavity, or double-cavity blocks, 18 in. long, 9 in. wide, and up to 9 in. deep. The depth of block is varied by using palettes of different thicknesses. The machine is of fabricated construction, and the design is simple and robust. The tamper, being counterbalanced, is easy to rock, but it provides a heavy blow. Messrs. Flexible Non-Metallic Conduits, Limited, 208, Tottenham Court-road, London, W.1, exhibit novel flexible conduits made of plastic. They are plastic tubes, tough, damp-proof, non-inflammable, proof against almost all chemical fumes, petrol and oil, and they do not "age." When buried under plaster, etc., they do not rust or corrode, condensation does not occur, as with metal conduits, and owing to their flexibility they are readily installed with a minimum of components. Screwed fittings, etc., for these conduits are made of Bakelite or cellulose acetate.

Machines for the paint trade are well represented in the Exhibition. Messrs. G. J. Worssam and Son, Limited, Overbury-road Works, Seven Sisters-road, London, N.15, are showing, on the stand of the Keenok Company, Limited, a 30-in. by 15-in. box-frame three-roll paint mill, which is illustrated in Fig. 4, on this page. It is the largest in a range of four mills of this type, and is generally supplied with water-cooled chilled-iron rolls, but granite rolls are also available. The machine incorporates roller bearings, Tecalemit automatic pressure lubrication, and skew gears running in an oil bath. The Keenok Company, Limited, 13, City-road, London, E.C.1, exhibit several wet milling and mixing machines, including a high-speed mixer known as the "Keenowhirl," which is illustrated in Fig. 5, on this page. It is generally used for refining before canning, and accommodates portable containers of 40 to 115 gallons capacity. The rotating units, or "whirls," are made in different sizes to suit the containers, and are designed to reduce aeration to a minimum. Messrs. Sidney Smith Industries, Limited, 261A, High-road, Chiswick, London, W.4, are showing several of their well-known machines for the paint industry. We may mention particularly a 7-ft. edge-runner, a triple-roll mill, a single-roll mill, and a "Whirlpool" mixer.

A simple but interesting exhibit is to be found on the stand of Messrs. K. J. and A. Sommerfeld, Limited, Trench Works, Wellington, Shropshire—a firm well known for their Sommerfeld track, which was used extensively by the Services during the war. It is a joist designed to replace the conventional builders' timber joist, and especially to economise in wood. It comprises a Warren-type truss fabricated from steel rod, with a wooden batten along the top and bottom, and is known as the 5·25-in. joist, this dimension being the depth of the steel truss. The thicknesses of the two battens increases the depth to 7 in. About 80 per cent. of a builder's timber allocation can be saved by using these joists, and as the steel components are made from scrap Sommerfeld track, there is no difficulty in obtaining steel. The same firm are also manufacturing portable track for making

temporary surfaces over bad ground suitable for wheeled vehicles.

Messrs. Twisteel Reinforcement, Limited, Alma-street, Smethwick, show models of buildings constructed with the firm's recently introduced "barrel vault" roofing. It consists of a thin curved shell of reinforced concrete rigidly held at each end by stiffening or spandrel beams supported on columns or walls. The principal advantages of this system are stated to be: large spans with unobstructed floor space and roof space, consequently even distribution of daylight and an absence of dust-retaining roof members, good acoustics and a pleasing appearance. Messrs. Structural and Mechanical Development Engineers, Limited, Slough, Buckinghamshire, are showing a 21-ft. light-alloy roof span, and models and photographs to illustrate this type of construction. Messrs. Williams and Williams, Limited, Reliance Works, Chester, exhibit their Aluminex roof-glazing construction, which is fabricated from light-alloy sections. It has been used for the Bristol "Brabazon" aircraft assembly hall.

The Jones cranes, marketed by Messrs. George Cohen, Sons, and Company, Limited, Chase-road, London, N.W.10, have been described in our columns on previous occasions, but a new model is shown on the firm's stand at the Exhibition. It is a 15-cwt. mobile crane which will travel and slew under its own power, carrying the full load suspended from the jib. Power is provided by a Coborn 6-h.p. petrol engine, which is air cooled to avoid the risk of damage due to frost, inseparable with a water-cooled engine under the conditions existing in builders' and contractors' work. The crane travels on four wheels which are supplied with either solid-rubber or pneumatic tyres. The standard jib is 16 ft. long, lifting 15 cwt. to a height of 14 ft. 6 in. at a maximum radius of 7 ft. With the jib derricked to its lowest position, a load of 4 cwt. can be lifted 4 ft. 6 in. above ground level. Extension masts can be supplied to enable the crane to lift 12 cwt. at 6 ft. 6 in. radius to a height of 20 ft., or 6 cwt. at 7 ft. radius to a height of 35 ft.

Muir-Hill dumpers, manufactured by Messrs. E. Boydell and Company, Limited, Elsinore-road, Old Trafford, Manchester, 16, have also been described in ENGINEERING, but this firm are exhibiting three new models, Nos. 10B, 14B, and 20B, at Olympia. The 10B dumper is the smallest machine in the range, and has a capacity of 2·53 cub. yds. "struck" and 3·13 cub. yds. "heaped." Three types of bodies—standard, quarry and concrete—are available. The 14B dumper has a capacity of 3·67 cub. yds. "struck" and 4·29 cub. yds. "heaped." The unladen weight is 4 tons, and the dumper is suitable for travelling on public roads. The 20B model is a large dumper with a capacity of 5·26 cub. yds. "struck" and 6·03 cub. yds. "heaped." It is driven by a 7·7-litre A.E.C. Diesel engine, developing 96 b.h.p. at 1,800 r.p.m.

INFRA-RED LAMP DEMONSTRATIONS.—An infra-red electric lamp demonstration department has recently been established by Metropolitan-Vickers Electrical Company, Limited, at 132-135, Long Acre, London, W.C.2. This has been equipped with four different types of plant, with a total load of 75 kW, so that tests can be made on a wide range of articles. Included in the installation is a 6-ft. spray booth and compressor unit, so that tests on paint stoving, moisture extraction and pre-heating can be carried out.

THE BROOK CONTINUOUS FILM-PROJECTION CABINET.—The Brook film-projection cabinet, which has been developed by Sound Services, Limited, 296, Kingston-road, Merton Park, London, S.W.19, has been designed to provide a continuous reproduction of films, in shops, railway stations and exhibitions, where the audience is constantly changing, as well as in factories and schools, where it is desirable to repeat information at frequent intervals. A 16-mm. film is used, the pictures of which are projected by mirrors on to the screen. The film is then wound round a series of small pullers placed in a circle and arranged so that the portion that is first rolled up is also the first to be unrolled. About 1,600 ft. of 16-mm. sound or silent films can thus be operated continuously. Starting and stopping are effected by push buttons and volume control and tone control are provided. Two safety cut-outs are fitted, which stop projection automatically should the film break, and the film can also be stopped automatically at the end of the film. The projector operates on alternating current and is easily portable.

LABOUR NOTES.

THE writer of the editorial notes in the November issue of *Man and Metal*, the journal of the Iron and Steel Trades Confederation, is severely critical of fellow trade unionists who believe that a national wages policy would, at any rate, help to solve the country's present economic problems. "When," he says, "many people complain that the Government have no wages policy, or say that the Trades Union Congress should declare one, they do so without the foggiest notion of the wages structure in industry, or without the slightest idea of how such a policy could, in the first place, be evolved, and secondly, how it could be applied without the compulsion inherent in a totalitarian State. If by a wages policy is meant the stabilisation of existing wages, then this simply cannot be done, because there are many industries where the level of wages is already too low. Even within the confines of one industry, covered by the same agreements, wages vary considerably and are based on the relative degrees of skill required between one grade of employment and another, upon which the whole wages structure and manning of industrial processes is based."

"The unions have for many years been forcing the wages of the lower levels up," he goes on to say, and, although this has not been done without repercussions on the other grades, the unions would not agree to any wages policy that prevented this being done. The simple fact of the matter is that neither the Government nor the Trades Union Congress have power to impose any policy on the various unions, and any attempt to do so by legislation would obviously involve wider issues, one of the chief being the right of men to dispose of their labour on conditions and terms which they regard as adequate—which is fundamental in any democratic society. Whatever, therefore, is done to avoid the rise of wages after prices, and then price increases following wages increases—which if allowed to go on without some restraint, will end in disaster, in which the workers will suffer most—must be done by persuasion and education."

"With some notable exceptions," the note continues, "the organised trade-union movement has shown restraint in pressing wage demands, and we think it safe to say, they have only pressed for wage increases in the main when rising prices have compelled this. The Government must, therefore, do something about tighter price control and the extortionate profits made in some quarters today if that restraint is to continue to be exercised. The question of wages cannot be argued, or dealt with, in isolation, and it is simply beating the wind for anyone to think that wages can be halted or stabilised without the same degree of stabilisation being exercised over prices, and, indeed, some steps taken to remedy a state of affairs where traders can show three times the profit to-day on considerably less than their pre-war turnover of business."

A special delegate conference of the National Union of Mineworkers, held at Blackpool last week, unanimously approved the agreement on wages, negotiated by the executive, with the National Coal Board. The various areas are to ballot on the subject, the votes being returnable by December 3, and, if the rank and file accept the terms, the agreement will have effect as from the first full pay week in November.

The agreement as was briefly stated a week ago, provides for an increase in the minimum wages of adult underground workers from 5*l.* to 5*l.* 15*s.* a week, for an increase in the minimum weekly wage of adult surface workers from 4*l.* 10*s.* to 5*l.*, for an increase in the minimum weekly wage of juvenile underground workers equal to 15 per cent. to the nearest 6*d.*, and for an increase in the minimum weekly wage of juvenile surface workers equal to 11 per cent. to the nearest 6*d.* Shift rates payable to day-wage workers not affected by increases in the weekly minimum are as follows: adults (underground) increased by 2*s.* 6*d.* per shift with a maximum of 19*s.* 10*d.* per shift; adults (surface), increased by 1*s.* 8*d.* per shift with a maximum of 18*s.* 2*d.* per shift (both these maximum rates exclude the war addition and the "skilled shilling" where payable); juveniles (underground and surface) increased by 15 per cent. and 11 per cent., respectively, of the day rates provided in the Porter award.

The National Coal Board and the National Union of Mineworkers agree as to the nomenclature and grading of craftsmen and the determination of wages for each class and trade. On this point, Mr. James Bowman, vice-president of the union, said that craftsmen had not had wage improvements commensurate with their responsibilities and duties. Generally speaking, the grades would be tradesmen, such as blacksmiths, electricians, joiners, and the engine-winding men. Negotiations with the Coal Board would begin as soon as the draft agreement was accepted. It was intended to fix national rates similar to those received by men doing similar work in other industries.

In his latest quarterly report, Mr. William Roberts, the general secretary of the Bolton and District Card and Ring Room Workers' Association, expresses the opinion that the cotton industry cannot be expected to attract workers from other trades while it offers the same or lower wages. Cotton, he says, can afford to pay more to its workpeople in the departments in which members of the Association are employed, and however that is done, it must be done, he declares; otherwise there would continue to be a falling off in the fulfilment of the industry's requirements. Wages, he claims, are the deciding factor in the minds of most people; operatives gravitate where wages are best and they must hold out for that inducement if the industry is to receive sufficient labour to staff the mills.

Dealing with the introduction of part-time evening shifts, Mr. Roberts says that while they have been of assistance in increasing production, it has been proved that they cannot be relied upon to contribute substantially towards meeting the essential needs of the industry.

During the first four weeks of the operation of the Control of Engagement Order, there was a net gain of 1,541 workers in the cotton industry. This compares with an increase in man-power of only 900 during the first nine months of the year. In the week which ended on November 1, the labour gain was 362 against 203 in the previous week. Elderly mill hands and married women are no longer leaving the trade in such large numbers, and wastage has been cut down from 700 to 500 a week.

Under regulations promulgated by the Ministry of Economic Affairs of the National Government of China, a Skilled Workers' Training Department is responsible for the training of skilled workers. The Ministry of Economic Affairs may, however, co-operate with other bodies concerned with the organisation of a planning committee for such training. As a rule, the actual task of training is entrusted to State and privately-owned factories and others, but, if necessary, the Skilled Workers' Training Department may open a teachers' training class with the approval of the Ministry. Every State-owned or privately-owned, factory or mine employing over 100 skilled employees is obliged to provide facilities for training, and the number of trainees enrolled by it must not be less than 5 per cent. of the total number of skilled employees originally employed. The types of undertakings which are to set up skilled workers' training classes, together with their quota of trainees, are as follows: factories and mines under the National Resources Commission, 8,000; plants under National Defence, 2,500; Government railway plants, 1,000; other State-owned factories and mines, 2,500; and various privately-owned factories and mines, 2,500. Although the expenditure on the training is to be borne by the factory or the mines concerned, the Skilled Workers' Training Department will grant annual subsidies for the purpose.

The aim of the regulations is the training of 10,000 skilled employees in the construction of machinery, 1,000 in the production of electrical appliances, 1,000 in the manufacture of chemicals, 500 in mining, and 500 in metallurgy. With a view to facilitating the promotion of training, the country is divided into eight regions which, together with their respective centres, are as follows: the south-east region (Shanghai), the south-west region (Chungking), Central China region (Hankow), the south China region (Canton), the north China region (Tientsin and Tsingtao), the north-west region (Sian), the north-east region (Mukden), and the Taiwan region.

The duration of the training course will be three years, the first of which will be devoted to general training and the remaining two to training in a specific skill. Practical training will be emphasised, and, out of 48 hours of weekly training, no more than 10 will be used for theoretical courses. Any person over 14 years of age with a primary school education or its equivalent may qualify as a trainee. Applicants for the course must pass an entrance examination, and each trainee must have a guarantor who will be responsible, among other things, for the maintenance and good behaviour of the trainee during the training period. Trainees are not allowed to withdraw before the end of their term.

MANUFACTURE OF CAST-STEEL BOMB BODIES.

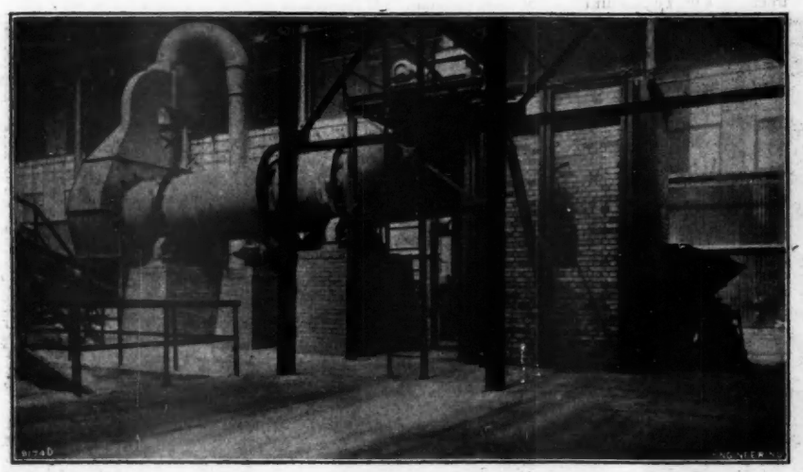


FIG. 5. DRIER FOR NEW SAND.

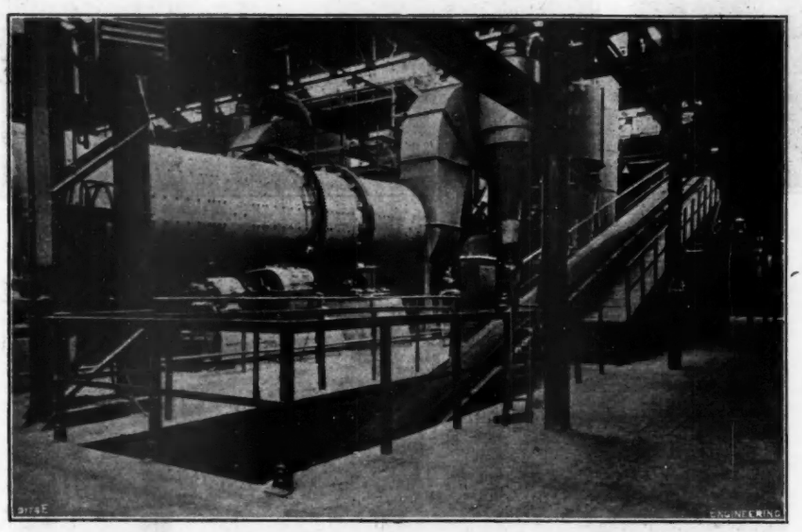


FIG. 6. ROTARY SAND COOLER AND DUST-EXTRACTION PLANT.

THE MANUFACTURE OF CAST-STEEL BOMB-BODIES.*

By PERCY H. WILSON, O.B.E., M.I.Mech.E.

(Continued from page 503.)

THE ladle shells were of nominal 4½-ton size. They were lined with 41 per cent. alumina firebrick circles on edge, with the bottom three courses 2½ in. thick and the remainder 2 in. thick. The bottom was covered with a layer of sand and a course of squares laid on edge, giving a thickness of 4½ in. A specially-moulded internal "teapot" spout was built into the ladle. All joints were of 42 per cent. alumina fireclay. The internal spout reduced the capacity of the ladles to 3½ to 4 tons. The life of the ladle linings was 30 heats, with a new spout every 20 heats. The ladles were kept hot by placing over gas burners.

Routine laboratory control included analyses of all raw materials, cupola metal, slags and the complete analyses of each heat of steel. Test bars were prepared and broken in a specially equipped test house adjoining the laboratory. Having regard to the output of steel required for the operation of this foundry, the number of ladles and other vessels was relatively small. There were five cupola receivers, eight 8-ton teeming ladles, four rotary-furnace shells, 12 converter bodies, and 24 steel ladles. The metal requirements for 6 heats per hour were obtained from the use of one cupola, one rotary furnace and two converters; a typical time schedule is shown in Table III. The metal losses in the process were approximately as follows: cupola, 5 per cent.; rotary furnace, nil; converter, 9 per cent. Quite apart from any considerations arising from the saving of shipping space, at a time when the supply position of imported ferrosilicon and hematite iron was at its worst, the successful operation of this process did in fact achieve a substantial saving in the cost of the remelted metal.

TABLE III.

Operation.	Time.
	Minutes.
Tapping cupola	4
Pouring into second ladle	2
Raking off slag	2
Pouring into rotary furnace	2
Tapping rotary furnace	1
Pouring into converter	1
Setting tuyeres	1
Blowing time	12
Slagging	2½
Deoxidising	¼
Alloying	1
Emptying converter	1

The design and operation of the foundry will now be dealt with. Immediately following the approach to the writer, first by the Ministry of Aircraft Production and later by the Ministry of Supply, experiments were commenced with a view to determining the moulding methods to be adopted, and at the same time to obtain data on other major factors affecting the design and lay-out of the plant. Drawings of the finished castings are shown in Figs. 1 and 2, on page 501, *ante*. At the outset, it was realised that the adoption of any form of mould drying would entail the provision of drying equipment on a very large scale, if the required rate of output (100 castings per hour) was to be achieved, and accordingly efforts were directed towards perfecting a moulding technique whereby green-sand moulds could be used. After various trials, an adequate source of supply of suitable sand was located, and the practicability of using green-sand moulds was established.

It was decided to cast the bombs vertically in pairs with the nose end in the drag half of the mould. The castings were poured through a single downgate lined with fireclay sleeves, and the metal entered the moulds through two ingates, arranged tangentially to the circumference of the bomb body so as to avoid direct impingement on to the core. The ramming of the moulds was carried out by sandslingers working in conjunction with simple down-draw stripping plate machines. To produce the requisite output of cores to form the inside profile of the bombs, it was obvious that every possible operation would have to be mechanised, especially in view of the fact that only female labour was available for coremaking. The cores were carried on steel core bars wrapped with wood-wool rope, on to which the core sand was rammed. For the actual ramming of the core a specially designed ramming machine was evolved which consisted of a turntable provided with three stations at which the ramming of the core was progressively carried out. There were eight machines, each operated by four women, and the rate of output was slightly in excess of 20 cores per hour per machine.

The heart of the foundry was the endless mould conveyor, 230 ft. long and 40-ft. centres, consisting of a complete articulated train of 58 bogies. The normal loading of the train was approximately 380 tons. Moulding sand, cores and molten steel all converged to this point and from it the castings were taken for further operations. The general layout of the foundry comprised a sand-handling and preparation plant, core-making section, moulding section, and fettling and despatch section, all of which are separately described in detail in the following paragraphs. The main building consisted of four bays, 537 ft. to 582 ft. long, and 45 ft. to 50 ft. span, with a further bay 275 ft. long. The total area of the main and subsidiary buildings was approximately 120,000 sq. ft.

The design of the sand-handling and preparation plant was based on the use of one grade of sand throughout. The core sand was rejected after use, but the used moulding sand was kept in the system and reconditioned with various additions for moulds and cores. The revivification consisted of the addition of new sand equal in amount to the rejected core sand, the normal proportions being 70 per cent. used and 30 per cent. new sand. Chelford silica sand from two sources was used. There were two storage hoppers for new sand in a separate building, each with an approximate capacity of 90 tons. A system of conveyor belts carried the sand to a rotary-drum drier in the main building where it was dried to a maximum water content of 0·5 per cent., and delivered to a 10-ton storage hopper. The new-sand drier is shown in Fig. 5, on this page.

Used moulding sand was conveyed from the mould knock-outs by an inclined belt which travelled under an overband magnetic separator. This sand was delivered into a 40-ton hopper through a ¼-in. rotary trommel screen which contained a device for breaking down the larger lumps and rejecting superfluous material. The two storage hoppers were erected in line with each other, and were bounded on each side by a conveyor belt. The bottom of each hopper consisted of two belts delivering the sand on each side to this conveyor. The sand was fed at a rate controlled by the height of suitably placed gates in the side of the hoppers and the mixed sand deposited on the conveyor belt was delivered into two rotary coolers, one of which is shown in Fig. 6.

The coolers consisted of large drums with internal cruciform construction each capable of handling 30 tons of sand per hour. They were 43 ft. long and 7 ft. 10 in. diameter, driven by gear and pinion from a 30-h.p. motor through a three-speed reduction gearbox. Each of the coolers was provided with a large centrifugal fan, by which air was drawn through the sand, extracting the fines and cooling the sand. The heavier particles settled into a sump and were delivered outside the building by a short cross belt conveyor. The remainder passed through cyclones, to be delivered finally by screw conveyor on to an inclined belt which discharged into a storage hopper located over railway wagons outside the shop. The mixed, desilted sand was delivered by conveyor to eleven storage hoppers, one situated over each sandmixer.

The speed of the fan in the desilting operation could be varied to give different measures of extraction, but as casting conditions and the new sand were fairly

* Paper entitled "Mass-Production Methods Applied to the Manufacture of Cast-Steel Bomb Bodies," presented at the 44th Annual Conference of the Institute of British Foundrymen, at Nottingham, on Wednesday, June 18, 1947.

MANUFACTURE OF CAST-STEEL BOMB BODIES.

FIG. 7. CORE-MAKING MACHINE.

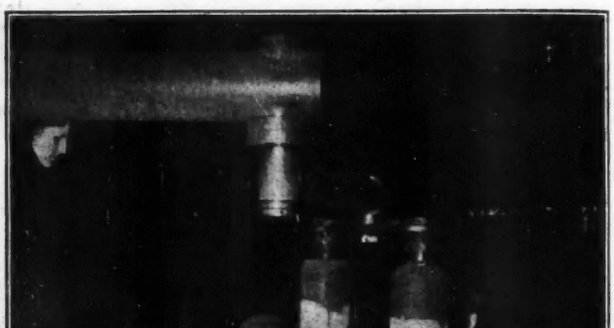


FIG. 8. INSERTING CORES INTO MOULDS.

constant, it was possible to run successfully with one setting. Once this was established, the removal of fines, silt and dead clay resulted in the grading of the reconditioned sand throughout the operation of the foundry being similar to that at the commencement on 100 per cent. new sand. The characteristics of the material removed were approximately 90 per cent. fine sand and silt grades with 10 per cent. clay grade.

Situated between the storage hoppers and the sand mixers, were eleven corresponding batch hoppers, into which the correct amount of sand for each mix was fed automatically by adjustable gates and conveyor belts which formed the bottom of the storage hoppers.

Moulding sand was mixed in eight No. 3 August-Simpson mixers in batches of 1,300 lb., with bentonite to give a content of 4 per cent. It was established that 10 per cent. of the bonding material was lost during casting and desilting. Bentonite was added to make up this loss and the full 4 per cent. was added for the proportion of new sand in the mixture. Various moisture contents were tried, but it was established that 2·0 per cent. at the sandslingers was the best from the point of view of both slinging and the finished castings. A slightly higher moisture was added at the mills to compensate for losses *en route* to the sand-slinger hoppers. A total mixing time of 6 minutes was allowed, and resulted in the following moulding properties. The permeability number of the green moulding sand was 180 and of the baked sand 220; the compression strength of the green moulding sand was 4 lb. per square inch and that of the baked sand 45 lb. per square inch. The amount of sand required for a complete mould was 12½ cwt.

Three No. 2 August-Simpson mixers were provided for mixing the core sand in batches of 730 lb., with a total mixing time of 4½ minutes. Table IV shows the

TABLE IV.

Ingredient.	Quantity.	Parts.
Mixed sand from sand coolers ..	730 lb.	100
Cereal binder	10½ lb.	1·4
Water	25½ pints	4·35
Linseed oil	6 ,,	0·96

mixture used. The operator opened the batch hopper and allowed the measured sand to fall into the mill. The cereal was first added and the whole mixed dry for half a minute. The water was then added and mixing continued for 2½ minutes. Oil was added last, and the mixing was completed in a further 1½ minutes, following which the sand was discharged and conveyed by belt to hoppers over the automatic core-making machines. The moisture content at the core machines was 3·6 per cent. The water and oil additions to the sand were very accurately controlled by the following method.

FIG. 9. CORE BOGIES LEAVING CORE STOVES.

Cylindrical tanks were provided for both water and oil, with a gauge glass giving visual indication of the quantities of liquid in the tanks. A graduated scale was fitted and the operator opened a spring-loaded valve until the liquid reached the required level, the valve then being closed. To empty, a spring-loaded valve, which was fitted to the bottom of the tanks, was opened and the contents flowed into the mill. The permeability number of the green core sand mixture was 110, and that of the baked mixture, 180. The compression strength of the green mixture was 4 lb. per square inch, and that of the baked mixture, 400 lb. per square inch.

The core bars were constructed of steel tubing, 4 in. in diameter, drilled with vent holes. There was a finned base into which was screwed a taper pivot-pin, and the head of the bar was a steel casting bored to receive the centring bars and to allow the escape of gases generated during casting. Two grooves were machined round the head, for the purpose of hanging the cores for transportation, specially constructed hooks being provided for this purpose on the core-drying bogies and conveyors.

As already stated, the core bars were wrapped with 1-in. wood-wool core rope, for a length of 25 in. from the bottom of the bar, on upright motor-driven machines with foot-operated control. Two ¼-in. square wooden pegs were pushed through the bar to prevent

movement of the wood wool during subsequent operations. About ten turns of thin twine were wrapped over the base of the bar from a point approximately 1 in. above the pivot-pin, carried over the wood wool and secured. This string formed a surface to support the nose portion of the core, which invariably cracked and parted from the body of the core until this practice was developed. After wrapping, the upper part of the wood wool was secured by springs, the core bars were suspended on an overhead chain conveyor and singed. This conveyor, which had a 538-ft. circuit, took the bars within easy reach of the coremaking machines.

In the coremaking operation, eight automatic ramming machines were provided. Each of these consisted of a sand-storage hopper with a disc base, which fed the sand down suitably-located chutes to the ramming stations, an automatic rammer, and a turntable on which three core boxes were situated. As can be seen in Fig. 7, opposite, each core box was made in two hinged sections, one above the other. They were closed by quick-release catches at the first and second ramming stages, and two separate hinged sections were mounted on the other two at the third stage. At the first station, the core bar was dropped into the box, and the head of the bar centralised by means of a short length of tube fixed to the main frame by a sleeve. The nose of the core was rammed by hand, and the second section of the core box clipped into place.

At the second station, the main body of the core was rammed with the automatic rammer. This was a vertically reciprocating rammer head of 7 in. diameter, connected to a driven crank through friction bushes, which allowed the rammer head automatically to adjust itself to the rising height of the sand in the core box, the friction grip arrangement controlling the density of the rammed core. The turntable was pushed round by hand until it reached the correct position, where it was fixed by a dog pushed into a slot on the turntable. After centralising the bar, the rammer was pulled down to the level of the sand already rammed, and both rammer and sand feed started, the box being rotated mechanically during ramming. The body of the core was completely rammed in 55 to 60 seconds, and the rammer was lifted above the core bar head so that the core box could be moved to the next station. Here, the final sections of the core box were clipped into place and ramming was completed by pneumatic rammer, after which the box was returned to the first station for stripping. The core was removed from the box by a small balanced jib crane, with a brake which held the core in position while it was painted. The paint mixture, which was brushed on by hand, contained 224 lb. of molochite, and 20 lb. of bentonite, and was mixed with water to a specific gravity of 1·45. The core was then placed on the core-drying bogie, which could accommodate ten cores on arms mounted on a rotating spindle. Two of these bogies can be seen in Fig. 9, opposite.

Four core-drying stoves were provided and used when the foundry was engaged on the production of thick-section general-purpose bombs. After the changeover to the thinner section medium-case bomb, it was found that the work could be carried out in one stove only. The reason for this was that a skin baking to a depth of $\frac{1}{8}$ in. to $\frac{1}{4}$ in. gave the necessary degree of collapsibility in the most practicable manner, provided that the cores were used within one hour of baking. A second stove was used for warming up cores after a week-end or at the commencement of a shift. Each stove was divided into three zones—the preheating zone contained five bogies, the baking zone contained eight, and the cooling zone two.

Over a considerable portion of each shift, the hot air exhausted from the cooling tunnel during the cooling of the castings was conducted to the preheating zone and sufficed to maintain the temperature required in this zone. Gas was used to adjust any deficiencies and also to heat the soaking zone, the temperature being thermostatically controlled. Hot air for recirculation was drawn by fan from the cooling zone and was premixed at the burner. An indicating controller was fitted, and a motor and reduction drive was arranged to operate the air and gas valves. The temperature was controlled within ± 5 deg. C.

The cores were pushed in the stove on the bogies, by means of an electrically-driven pusher, at intervals of 6 minutes, ten cores per bogie. At this speed, 100 cores per hour were being dried in one core stove, the preheating temperature was 100 deg. to 110 deg. C., and the drying temperature in the baking zone was 200 deg. C. Core bogies emerging from the core stoves are seen in Fig. 9, opposite. The cores received a second coat of a sillimanite-bentonite paint at the exit end of the stoves, after which they were allowed to stand approximately 30 minutes for the paint to dry out and harden. Each core was gauged for contour and diameter before placing on the conveyor to the core-setting platform.

We come now to the moulding operation. Four sets of nose-end patterns were provided, each set comprising two nose-end patterns with ingates, fitted to a pattern plate measuring 2 ft. 9 in. by 2 ft. $0\frac{1}{4}$ in. Each of these was fitted to a down-draw moulding machine by which the patterns were drawn through a stripping plate to clear the moulds before removal. The ram on these machines was operated by compressed air, at a pressure of 90 lb. per square inch, through an oil cylinder $8\frac{1}{2}$ in. diameter fitted with a dash-pot and regulating valve. Double-arm air hoists running on telpher joists were used to transfer the rammed drags to the mould conveyor. Four sets of base end patterns were provided (two in a set) fitted to a pattern plate with loose head fitted over a sleeve. There was also an internal riser and a rod over which fireclay sleeves were placed to form the down gate. They were fitted to down-draw moulding machines, similar to those provided for the nose-end patterns.

The copes were transferred to the mould conveyor, by means of air hoists. The mould conveyor consisted of 58 steel chassis, connected by bogies, which formed an endless train; each chassis carried four plates in sections and was constructed to carry two complete moulds. The conveyor was moved forward by two 18-in. air cylinders, each having an 11-ft stroke. The movement of the conveyor was controlled by a female operator, from a raised platform, which gave an uninterrupted view of the whole of the operations in the moulding bay. A warning hooter was sounded before each movement of the conveyor.

The sand was delivered from the mixers by two conveyor belts totalling 450 ft. extending into hoppers above the sandslingers. These hoppers were fitted with feed belts, motor driven through a reduction gearbox, the rate of sand feed being controlled by the height of gates located at the base of the hopper. Four sandslingers were provided, the impeller heads being 22 in. in diameter, directly coupled to a 20-h.p. motor running at 1,450 r.p.m. Two sandslingers were used for ramming drags, where a hard mould was essential. The time taken per drag was 1 minute 20 seconds, and all drags were inspected for mould hardness after being placed on the conveyor. The moulds were sprayed with a weak solution of sulphite lye, one pint to one gallon of water. This reduced the possibility of erosion by slightly hardening the mould surface during air drying which took place in the period between ramming and casting.

Two further sandslingers were used for ramming the copes, each cope being rammed in one minute; no difficulty was experienced with mould ramming or variation in hardness. Surplus sand from the slinger operations was strickled off the moulds and fell through grids from which it was returned directly to the feed hoppers by conveyor and elevator.

The down-gate of the mould was formed with $1\frac{1}{2}$ in. bore fireclay sleeves, through which the metal flowed to a sump 4 in. deep. Two bombs were cast in each box and the ingate was set at an angle, so that the metal entered the mould tangentially to avoid direct impingement on the core. An internal riser was situated at the junction of the two ingates to create a hot spot and to act as a feeding head. Bombs cast without this head were either porous or badly sunk under the ingate. A metal chill was used to support the core. This chill was bolted to a cross-bar, which extended through slots in the drag and it was bored to take the pivot pin of the core bar. The chill was centralised by a pin on the nose of the pattern and the bar was held in position by taper cotters, which were tightened before slinging commenced.

The core conveyor gave a maximum delivery of 150 cores per hour at the core-setting platform, thus giving flexibility which enabled the mould output to be increased when required. A stop button was provided on the platform, to prevent unused cores from passing this stage. The cores were taken off the conveyor in pairs by pneumatic double-arm jib cranes, which lowered them simultaneously into the moulds, the cores being guided into position by two women operators, while a third controlled the crane, as may be seen in Fig. 8, opposite.

(To be continued.)

GENERATION OF ELECTRICITY.—The official returns rendered to the Electricity Commissioners show that 3,725 million kWh of electricity were generated by the authorised undertakings in Great Britain during October, 1947, compared with 3,735 million kWh in the corresponding month of 1946, a decrease of 10 million kWh, or 0·3 per cent. For the first ten months of 1947, the total electricity generated was 34,164 million kWh, compared with 32,934 million kWh in the corresponding period of 1946, an increase of 1,230 million kWh, or 3·7 per cent. The total quantities sent out during October, 1947, and October, 1946, were 3,512 million kWh and 3,528 million kWh, respectively, a decrease of 16 million kWh, or 0·5 per cent. In the first ten months of 1947 the total amount of electricity sent out was 32,222 million kWh, compared with 31,062 million kWh for the corresponding period of 1946, an increase of 1,160 million kWh, or 3·7 per cent.

CATALOGUES.

Automatic Drilling and Tapping Machines.—A brochure containing a fully-illustrated description of their new range of automatic drilling and tapping machines has been sent to us by Messrs. A. A. Jones and Shipman, Limited Narborough-road South, Leicester. Two models are available, one capable of drilling holes up to $\frac{1}{4}$ in. in diameter; the other is for holes up to $\frac{1}{2}$ in. in diameter.

Sodium Lamps.—A leaflet issued by Philips Electrical Limited, Century House, Shaftesbury-avenue, London, W.C.2, gives technical data on the sodium lamps made by them, as well as on the associated fittings and apparatus. These lamps are designed for either interior or exterior industrial lighting, and it is stated that their golden-yellow light gives excellent visibility and definition of detail without glare.

Oil-Engined Generating Sets.—Associated British Oil Engines, Limited, 32, Duke-street, St. James's, London, S.W.1, have sent us a catalogue describing their ABOE 55 self-contained oil-engined generating set. This set has been produced in conjunction with the Brush Electrical Engineering Company, Limited, and the Ministry of Supply, and was described in ENGINEERING on page 242, *ante*. The catalogue gives full details of the engine, alternator and switchgear, and, in addition, makes several useful suggestions regarding installation, cost of operation and auxiliary services.

Mining Equipment.—In view of the importance attached to coal production, Messrs. Sigmund Pumps, Limited, Team Valley, Gateshead, have introduced a scheme whereby priority is given to the provision of pumps for use in coal mines. This service was originated in June of this year, and in order to provide an easy form of reference to the various types of pumps available, Messrs. Sigmund Pumps have prepared a leaflet giving details of the pumps suitable for main-shaft work, outbye work, coal-washing plants, general utility purposes, etc. The leaflet is fully illustrated and gives the leading particulars for each type of pump.

Pneumatic Equipment for Aircraft.—Messrs. The Hymatic Engineering Company, Limited, Redditch, Worcester, have issued a monograph for use by designers in the aircraft industry. This publication traces the development of high-pressure compressed-air generating equipment, with particular reference to its application to gas-turbine propelled aircraft wherein a high degree of supercharge is obtained by bleeding air for the intake from the turbine compressor. While the monograph is not intended to be a catalogue of pneumatically-operated components, details of various units are given in order to illustrate the possibilities of compressed air as a medium for power transmission in aircraft.

Diesel-Engine for Industrial Purposes.—We have received from Messrs. The Coventry Victor Motor Company, Limited (Diesel Division), Cox-street, Coventry, a leaflet giving details of their WDI-5/7-h.p. and WD2-7/9-h.p. single-cylinder Diesel engines. The leaflet also includes details of the various standard sets employing these engines, such as portable power sets fitted with V-belt pulleys for driving machinery, portable generators and portable pumping sets. A description of the marine types of these engines is included, together with some details of the ancillary equipment, such as propellers, etc., available for use with the marine units. The leaflet is fully illustrated and contains several dimensioned line diagrams.

Industrial Power Units.—A loose-leaf catalogue describing equipment fitted with Ford industrial engines has been issued by the Ford Motor Company, Limited, Dagenham, Essex. The catalogue is divided into various sections each of which gives full details, under the appropriate heading, of plant using this type of engine. The folder also includes a section describing the four types of engine available for industrial purposes, namely, the 8-h.p. and 10-h.p. four-cylinder engines, the 30-h.p. V-8 engine, and the four-cylinder Fordson Major tractor engine, which can be operated either on petrol or vaporising oil. The details given include line diagrams and performance curves for each type of engine; the catalogue is profusely illustrated.

V-Belt Drives. We have received from Messrs. J. H. Fenner and Company, Limited, Bick Lane Mills, Heckmondwike, Yorkshire, a copy of a booklet dealing with the use of V-belts for the transmission of power in the textile industry. The booklet has been compiled with the object of assisting those directly concerned with the modernisation of existing mills and all aspects of those problems likely to be encountered in fitting V-belt drives to both individual machines and line-shafting are discussed. In addition, there are sections dealing with more general subjects, such as the life of V-belts, the relation between durability and pulley diameter, V-flat drives, etc., so that, although the booklet was intended primarily for use by textile engineers, it contains much that is of interest to others.

NOTES ON NEW BOOKS.

Radio: A Study of First Principles. By ELMER E. BURNS. Third edition. D. Van Nostrand Company, Incorporated, 250, Fourth-avenue, New York, U.S.A. [Price 3 dols.]; and Macmillan and Company, Limited, St. Martin's-street, London, W.C.2. [Price 15s. net.]

WHERE a more strictly ordered development of complex receiving circuits from basic principles might easily damp the young enthusiast's ardour, this book reinforces it by plunging at once into the practical work of wiring up elementary circuits, so stimulating a healthy thirst for explanatory theory. This is supplied in subsequent chapters in a manner designed to hold theory in step with practical application. It is clear that the author has sound ideas as to what constitutes an essential minimum of theoretical study of his subject. His ability to express it concisely must be judged by the individual reader, but it is certain that the lover of good prose would not be happy with the staccato, short-sentence style of writing adopted; neither will the purist always be content with the definitions given of technical terms. This terse use of English, studded with American terminology, cannot be counted upon to give an unguided student all the clear conceptions he will need, although the class student, to whom the book is primarily directed, should not suffer in this respect. A simple, but adequate and well-illustrated, explanation of battery fundamentals, electromagnetism, Ohm's Law and electric circuits is given before the reader is introduced to the basic principles of electron tubes, detectors, amplifiers and other of the more complex units which feature in modern wireless receiving circuits. From first to last, the fundamental idea of electronic flow is kept in view, so that the explanation of A, B and C type amplifiers and of automatic volume control is easy to follow. This is true also of the portions, new to this edition, in which the principles of photo-electric cells and the cathode-ray tube are carried forward into an elementary treatment of the working of the iconoscope and kinescope in their application to television. Useful formulæ, including equations for resistances in parallel and condenser equations, are appended, and there is a good index which will greatly facilitate reference.

Power Station Efficiency. By C. W. PRIEST. Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, London, W.C.2. [Price 10s. 6d. net.]

THIS is an elementary little book dealing generally with the processes employed in central station work, and more particularly with some of the computations relating to the performances of the boilers, turbines and auxiliary machinery. The avowed aim of the author has been to narrow the gap between the information to be found in existing text-books on heat and the requirements of the average operator. In view of the great amount of literature dealing with power-plant operation, the existence of this gap is not very evident, and, in any case, the present book contains little or nothing with which the ordinary shift engineer would not be conversant; neither would it be of much more use in the laboratory, for, although a number of the ordinary combustion formulæ are given, such matters as sampling and testing of fuel, water, oil and flue gases are completely ignored. The presentation of the matter is generally clear, though the author definitely uses the word "adiabatic" as synonymous with "isentropic"; a statement implying that steam could not expand adiabatically in a perfect turbine working on a regenerative or re-heating cycle, which may be misleading. Again, he appears to consider that the only objection to trying to take into account the number of heaters when computing the ideal efficiency of a regenerative cycle is that this requires a much greater amount of work than calculating in the only legitimate way. The former method cannot be adopted without implying that an ideal cycle can contain thermodynamically irreversible processes, which is contrary to the definition of an ideal cycle. The method, moreover, would establish different and arbitrary standards for turbines working under identical steam conditions, according to the number of heaters employed; a procedure which would be just as irrational as it would be to make the efficiency of the Rankine cycle depend on the number of cylinders in the steam engine concerned. In dealing with the heat consumption of turbo-alternators, the author mentions "the Willans or Parsons line" as if these were merely different names for the same thing. The Parsons line, however, unlike that of Willans, has nothing to do with the performance of any individual machine, but represents the law of heat consumption for the entire station. As its main use is to provide an immediate check, shift by shift, on the overall operating efficiency of the power station as a whole, a correct explanation of it might have been included in a work of this kind with advantage.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

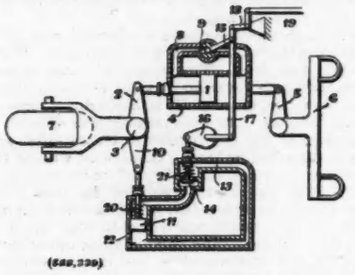
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification is given after the abstract in each case, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

588,339. Steerable Undercarriage Legs for Aircraft. General Aircraft, Limited, of Feltham, Middlesex, and O. Wels, of Feltham, Middlesex. (3 *Figs.*) February 12, 1945.—This invention applies particularly to steerable nose-wheel legs of tricycle-type undercarriages, the object being to provide means for locking the steerable leg effectually against angular movement when taking off or landing, and for quickly unlocking to permit of directional control by the pilot when taxying. A piston 1 is connected with an arm 2 provided on the steerable leg 3, the cylinder 4 containing the piston 1 being connected with a lever 5 on the rudder-bar or pedal 6, the piston occupying the central position shown when the leg 3 and its associated wheel 7 are centrally situated. Opposite ends of the cylinder are connected by a transfer port 8 containing a rotary type of valve 9 which, when opened as shown, will permit the free transfer of fluid from one end of the cylinder to the other. A second arm 10 provided on the leg is connected with a piston 11 contained in a cylinder 12, which is on the airframe, the ends of the cylinder being connected by a transfer port 13 containing a second valve 14, the two valves being interconnected so that they will be operated simultaneously, but in opposite senses, from a pilot-actuated control. The valve 9 is connected to a lever 15, a double-armed lever 16 being provided bearing on the stem of the valve 14. Levers 15 and 16 are connected by a link 17 which, in turn, is connected to a bell-crank lever 18, to which is attached a link 19 leading to a pilot-actuated control.

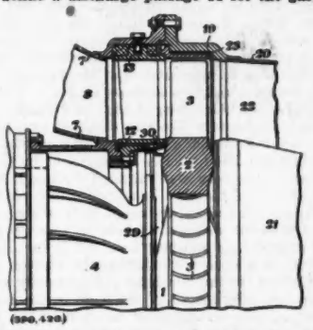


(588,339)

The piston in the cylinder connecting the steerable leg with a fixed part of the airframe is fitted with a spring 20 to maintain it normally in the central position shown. The second valve 14 associated with the cylinder 12 connecting the steerable leg with a fixed part of the airframe is of the spring-loaded type, the valve having an encircling spring 21. This valve can be opened against the action of its associated spring by a pilot-actuated control, the valve opening towards that part of the cylinder on the side of the connecting rod which serves to connect the piston with the arm on the steerable leg. As long as the spring-loaded valve is maintained open as a result of operation of the pilot-actuated control, the piston can move freely within the cylinder and the leg is free to be steered, the valve 9 associated with the cylinder connecting the steerable leg with the rudder-bar or pedal being closed. On the valve 14 being permitted to close under the action of its associated spring, however, the piston 11 is unable to move farther away from the dead-centre position than it was at the moment of releasing the valve. The piston is still free to move into its dead-centre position, the valve being opened temporarily by the fluid overcoming the force exerted by the spring on the valve, and the pressure of the fluid flowing from the front of the piston through the transfer port to the underside of the valve, which fluid pressure also assists to maintain the valve off its seating. In this way the valve will be opened temporarily to permit the piston to resume its normal central position. Any movement of the piston in the opposite direction will be resisted by the fluid, which will tend to force the valve back on to its seating. (*Accepted May* 20, 1947.)

INTERNAL-COMBUSTION ENGINES.

590,420. Gas Turbine. The British Thomson-Houston Company, Limited, of London. (1 *Fig.*) March 5, 1945.—The invention relates especially to gas turbines operated by gases from a combustion chamber. The objects of the invention are to provide a construction and arrangement of stationary shroud band which prevents warping, and to minimise leakage at the wheel rim. 1 indicates a turbine wheel having a rim 2 to which is attached a ring of turbine buckets 3, their radially outer ends being free. The wheel is carried by a shaft supported in bearings in a bearing housing 4. The walls 7 define passages 8 for conveying gases from a combustion chamber to a nozzle-ring structure which directs the gases to the buckets 3 of the turbine wheel. The annular walls 20 and 21 define a discharge passage 22 for the gases discharged from the turbine buckets. Surrounding the ring of buckets is a stationary shroud ring 23, which is arranged in spaced relation to the inner surface of wall 19 of the turbine casing and is supported on the right-hand adjacent edge of nozzle ring 13. Thus the stationary shroud ring 23 is free to move radially with ring 13; also, ring 23 is free to expand radially independently of ring 13. Between the end of bearing housing 4 and wheel 1 is an annular space 29 through which air is circulated for cooling the turbine wheel. It is desirable that leakage between space 29 and the space between inner nozzle ring 12 and rim 2 be reduced to a minimum. To this end, there is provided a pair of annular packing fingers 30 which have a close running clearance with the adjacent surface of the rim 2. (*Accepted July* 17, 1947.)



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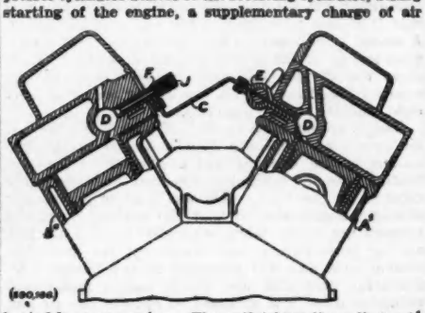
590,166. Starting Compression-Ignition Engines. Davey, Paxman and Company, Limited, of Colchester, and J. W. Onions, of Colchester. (2 *Figs.*) April 15, 1942.—The object of this invention is to facilitate the starting of a multiple-cylinder compression-ignition engine having a low compression ratio. For this purpose, pairs of cylinders are connected by pipes *c*, with valve controls, for the purpose of introducing to one cylinder of each pair during the compression stroke a supplementary charge of air heated by compression to raise the temperature to a degree sufficient to ensure ignition of the injected fuel on rotation of the engine. The cylinders are divided into compressor cylinders and receiving cylinders. The compressor cylinders deliver to the receiving cylinders, during starting of the engine, a supplementary charge of air heated by compression. The outlet from the cylinder A^1 is controlled by the shut-off valve E, and the inlet to the receiving cylinder B^1 is controlled by a non-return valve F. Upon rotating the engine, the cylinder A^1 has its fuel supply temporarily cut off, so that the compression stroke in the cylinder A^1 delivers air heated by compression to the combustion chamber D of the receiving cylinder B^1. The delivery of the heated air is timed to take place during the early stages of the compression stroke in the receiving cylinder. The delivery cylinder A^1 is fitted with a shut-off valve E which can be left fully open for the delivery of hot air during the starting process. The receiving cylinder B^1 is fitted with a non-return valve F loaded to a predetermined pressure by a spring J, and can be opened from the delivery side and closed automatically from the receiving-cylinder side as soon as the pressure is high enough in the receiving cylinder. (*Accepted July* 10, 1947.)



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